

*A webcomic of romance, sarcasm,  
math, and language*

**xkcd**

**RANDALL MUNROE**

**2020**

# xkcd

## 2020

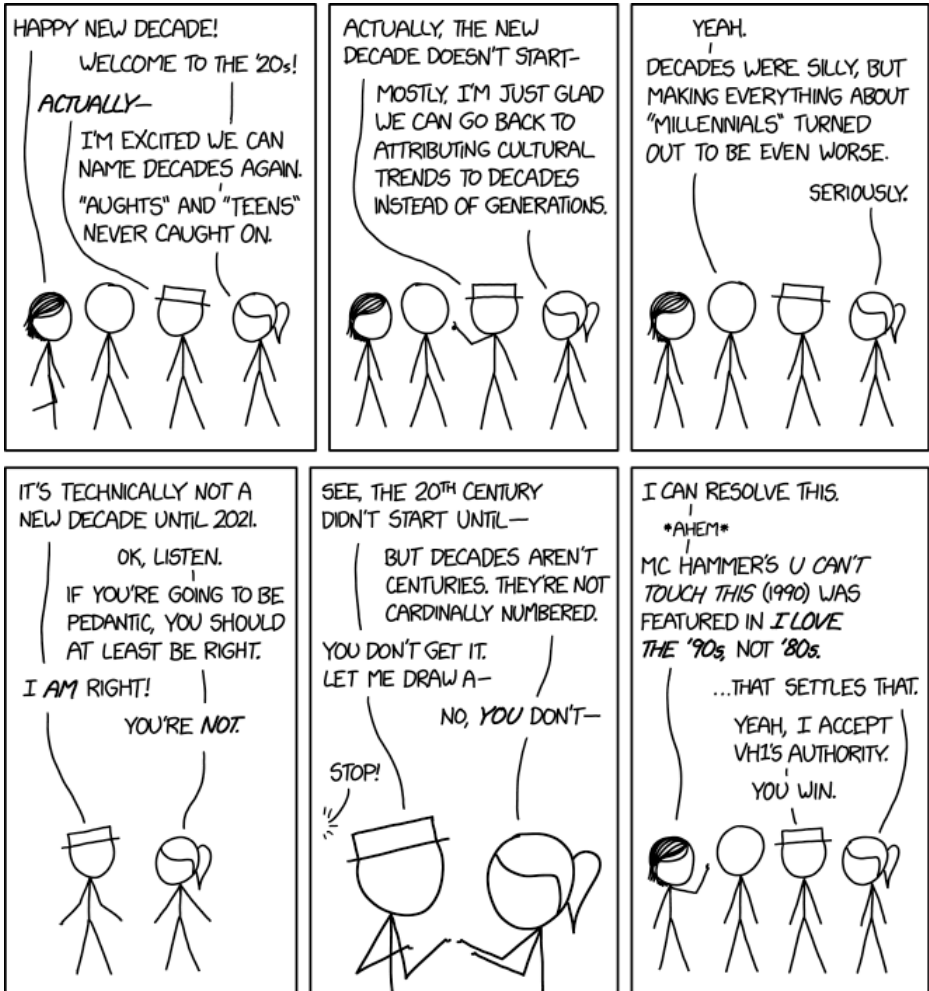
a collection of 157 webcomics

from #2249 to #2405

*by Randall Munroe*

## #2249: I Love the 20s

January 01, 2020



Billboard's "Best of the 80s" chart includes Blondie's 1980 hit "Call Me." QED.

## Explanation

This comic was released on the first day of the year 2020. It was the second of two New Year comics around the 2019-2020 New Year, after 2248: New Year's Eve.

The comic opens with Megan, Cueball, White Hat, and Ponytail celebrating the new year. Ponytail expresses relief that, they can now unambiguously name the decade "the 20s", since the decade has a well-defined name, any cultural trends that begin in the 20s can be attributed to the decade itself, and not to the generation that happens to coincide with it.

Prior to 2000, and particularly in the latter half of the 20th century, eras were often defined by decades, such as discussing the social movements of the 60s, or the music of the 80s. Beginning in 2000, this trend was noticeably reduced, most likely because the first two decades of a century didn't fit into the same naming convention, making it clunkier to discuss. "Aughts" and "Teens" were names suggested for the 2000s and 2010s respectively; however, neither of those names managed to gain widespread acceptance.

In this same era, there was an increased emphasis on generational cohorts, which Ponytail seems to see as a replacement for dividing time into decades. Millennials is a name given to the generation which was born in the 1980s through the mid 1990s. The term is sometimes used pejoratively by older generations who view



millennials as immature or complacent, and this was particularly common in the 2010s. It's possible that this focus on the generation was really a substitute for a focus on youth culture of that era. This is particularly notable since, as time moves on, Millennials continue to age, but the older generation still views them as the current youth. This phenomenon was previously discussed in 1849: Decades.

White Hat, however, raises a pedantic objection to Ponytail's celebration: he believes that the new decade does not properly start until 2021.

Ponytail corrects him on this, but he refuses to accept the correction until Megan cites an unlikely source: the fact that the VH1 television show *I Love the '90s* categorized MC Hammer's 1990 single "U Can't Touch This" as a 90s song, which supports Ponytail's definition of a decade. The joke is that a pop culture documentary is not an authoritative source for definitions of time standards,[citation needed] yet everyone is willing to immediately accept its authority on such matters anyway. Demonstrating the common usage of language is a valid argument, but the degree to which the authority of a single cable channel resolves the argument is unexpected.

The disagreement over the definition of when decades start is due to the fact that there is more than one way to count decades. You could do it in one of the following two ways:

- By counting every span of ten years that has occurred

since the start of year 1 in the Common Era (White Hat's definition)

- By taking the digit that is common to all years in a given ten-year span (Ponytail's definition)

White Hat's definition is an "ordinal" method since it functions by counting the number of ten-year spans since the first one, which is defined to have begun in the year 1. However, Ponytail's definition is the "cardinal" method, which simply groups years by their common most significant digits. For example, when we say "the 1980s", we mean "the span of ten years that all began with the digits 1-9-8".

Both definitions are internally consistent, but Ponytail's definition is clearly the more common one. She notes that this is not how decades are typically determined, and the fact that counting centuries in an ordinal way does not require that the same be done for decades.

White Hat's objection recalls an issue that was frequently discussed around the year 2000. Like decades, centuries may be counted ordinally ("20th century", "19th century", etc.) or cardinally ("1700s", "1600s", etc.). Unlike decades, the ordinal terms are always used for centuries in most languages, including English (except informally). Thus, much of the world celebrated the year 2000 as the start of the 21st century and of the third millennium, even though this was incorrect.

Megan's exclamation "Stop!" is similar to the line famously used by MC Hammer in "U Can't Touch This"

("Stop! Hammer time.").

Continuing the dubious "proof" offered by Megan, the title text goes on to use the Billboard Best of the 80s chart as proof that the 1980s started in 1980, as their chart includes Blondie's "Call Me", which was released in 1980. The title text ends with QED ("quod erat demonstrandum"), which means "which was [necessary] to be shown", and is traditionally used at the end of a mathematical proof, implicitly equating such pop culture references to unassailable logical evidence.

## #2250: OK/okay/ok

*January 03, 2020*

okay	ok	OK	O.K.
NORMAL	NORMAL	KIND OF OLD	LIKE AN ALIEN IMPERSONATING A HUMAN

HOW YOUR SPELLING OF "OKAY" MAKES YOU SOUND

After changing it back and forth several times and consulting with internet linguist Gretchen McCulloch, I settled on "ok" in my book *How To*, but I'm still on the fence. Maybe I should just switch to "oK."

## Explanation

This comic states how you 'sound' (as the typical narrative voice in your readers' collective heads) based on how you spell the word "OK" in your text. The word "OK", per Wikipedia, "is an American English word denoting approval, acceptance, agreement, assent, acknowledgment, or a sign of indifference." Many etymologies have been proposed to explain its origin. The Oxford English Dictionary and most other modern dictionaries say that it began in 1839 as "O.K.", a fanciful abbreviation for "oll korrekt" (all correct).

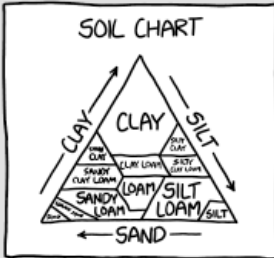
According to Randall, modern usage is to either have both letters in lowercase "ok", or the expression as a single word, with the sounds spelled phonetically: "okay". Using OK with both capital letters is kind of old, as the expression is almost never thought of as an abbreviation anymore. The original spelling of the word as "O.K." with periods after the letters is less commonly used in modern times, so Randall equates this usage to "an alien impersonating a human". (See for instance the last picture in this comic, 1530: Keyboard Mash for who might use that spelling).

The title text mentions Gretchen McCulloch, a Canadian Internet linguist. She focuses on trends in use of English words in online communications. Randall claims that he consulted with her on the use of "ok" in his book *How To* and after changing back and forth between different options he settles for "ok". But he is

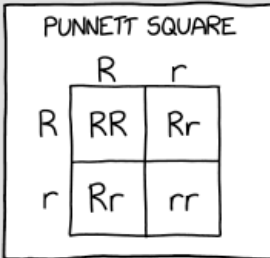
still unsure which version to use, and claims he is now considering switching to "oK.", a strange spelling that "compromises" between the three abbreviations, having one lowercase letter, one capital letter, and only one period. And ending the sentence with an abbreviation with a period inside the quotation marks also makes it uncertain if he means "oK" or "oK." as that can be debated. This was most likely on purpose knowing Randall's love for grammar rule and spelling. It is of course debated in this explanation's discussion.

## #2251: Alignment Chart Alignment Chart

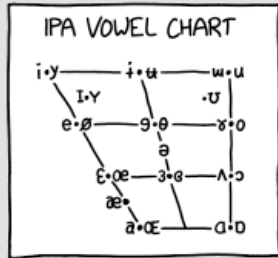
January 06, 2020



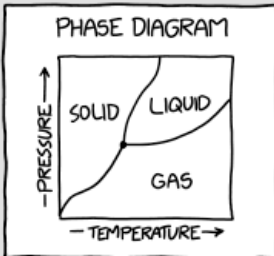
LAWFUL GOOD



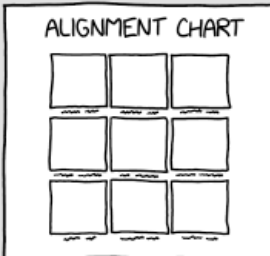
NEUTRAL GOOD



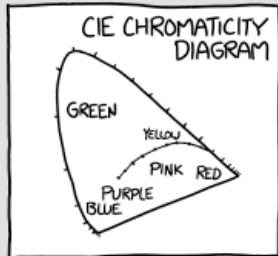
## CHAOTIC GOOD



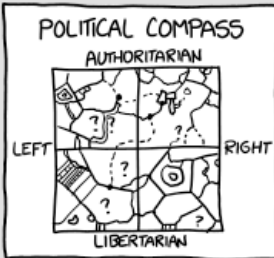
LAWFUL NEUTRAL



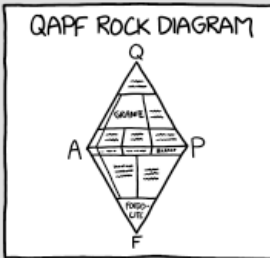
TRUE NEUTRAL



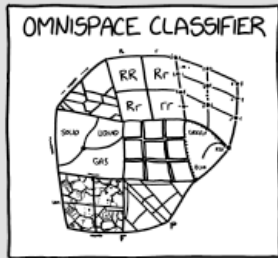
CHAOTIC NEUTRAL



## LAWFUL EVIL



## NEUTRAL EVIL



## CHAOTIC EVIL

I would describe my personal alignment as "lawful heterozygous silty liquid."

## Explanation

"Alignment" and "alignment charts" come from tabletop roleplaying games, most prominently Dungeons & Dragons. Every character has an alignment, which very roughly identifies their tendencies. The most widely used alignment system was introduced in the Dungeons & Dragons Basic Set in 1977 and has been reused in many (but not all) subsequent editions of the game. This system uses two perpendicular axes, each divided into three levels (for a total of nine categories). The two axes are:

- Lawful/neutral/chaotic: this axis says whether a character is strongly devoted to, indifferent about, or categorically opposed to following established rules.
- Good/neutral/evil: this axis says whether a character is generally inclined to commit good deeds or evil deeds.

In this system, the "lawful" attribute is independent from the "good" attribute. Lawful alignment means that a character is committed to a set of rules, which can refer to actual established laws, or to something like a rigid personal code, a set of traditions, or a chain of command, while a chaotic alignment means that a character has no interest in those, and may actively oppose them. The good vs evil scale is generally based on a character's concern for the lives and well-being of others; a good character will actively seek to help others and prevent harm, while an evil character will have no such concern and may actively harm others. Being 'good' is assumed to



be independent of being 'lawful'. For example, a character who actively breaks laws to help those who are unjustly imprisoned or oppressed would be considered to be "chaotic good". In both cases, a neutral alignment can indicate a character's indifference to a concept, or that their commitment is conditional, or that they consciously seek to balance both sides. A character with the "neutral neutral" alignment is called a true neutral.

An alignment chart is a grid that divides the alignments, usually for the purpose of putting descriptions or particular characters on it. Alignment charts are frequently used as a meme template, where humorous or absurdist things are organized into different alignments. In addition to the "classic" Dungeons and Dragons alignment chart, there are a number of variant alignment charts in use as meme templates. Many keep the three-by-three grid structure but replace the lawful-neutral-chaotic and good-neutral-evil axes with descriptions.

This comic claims to be a meta-alignment chart, where nine "alignment charts" are themselves sorted into the nine Dungeons and Dragons alignments, following the use of alignment charts to humorously classify abstract concepts. However, these "alignment charts" are mostly diagrams used in academic classifications, which are being treated as if they were blank meme templates. There are two levels of absurdity here: first, the idea of using these diagrams to classify things they were never intended for, and second, the conflation of chaos as a physics concept and an assigned moral weight as it

applies to each of these classification systems.

The title text describes Randall's alignment as "lawful heterozygous silty liquid" which references the true neutral, neutral good, lawful good, and lawful neutral charts in the Alignment Chart Alignment Chart. Lawful is the left side of an alignment chart, heterozygous is the top right or bottom left of a Punnett Square, silty is the bottom right of a soil chart, and liquid is the top right of a phase diagram. As such, the title text describes Randall's alignment as between Lawful Neutral and Neutral Good on this chart.

An alignment chart was also featured in 2408: Egg Strategies, which was published exactly one year later.

## #2252: Parenthetical Names

*January 08, 2020*



MY HOBBY:  
WHENEVER I MENTION ANYONE  
CALLED "<NAME> THE <X>," I PUT  
"THE <X>" IN PARENTHESES, LIKE  
I ADDED IT AS A CLARIFICATION.

I never got around to seeing that movie about the battle  
(of Midway).

## Explanation

This is another comic in the My Hobby series.

Parentheses are generally used in a sentence to add additional information that clarifies the topic. For example, in the sentence, "Barack Obama (a Democrat) is the 44th President of the United States," the parenthetical clause clarifies who Obama is, but is not strictly necessary to the sentence. However, in the comic, Randall uses parentheses for where they are not needed, either because the subject needs no clarification or because the parenthetical clause is so important to the subject that it should not be relegated to parentheses.

Sonic the Hedgehog is a video game franchise featuring the eponymous Sonic the Hedgehog character. Sonic is also the name of a train, a restaurant franchise, and a Californian internet service provider, among other things Randall is trying to avoid confusing the hedgehog with; however, it is unlikely that any of these would have movies made about them.[citation needed]

Jack the Ripper is the name attributed to a serial killer active in London in 1888. His true identity has never been confirmed, and he has been featured in hundreds of works. "Jack" is one of the most-common given names for males in much of the Anglosphere.

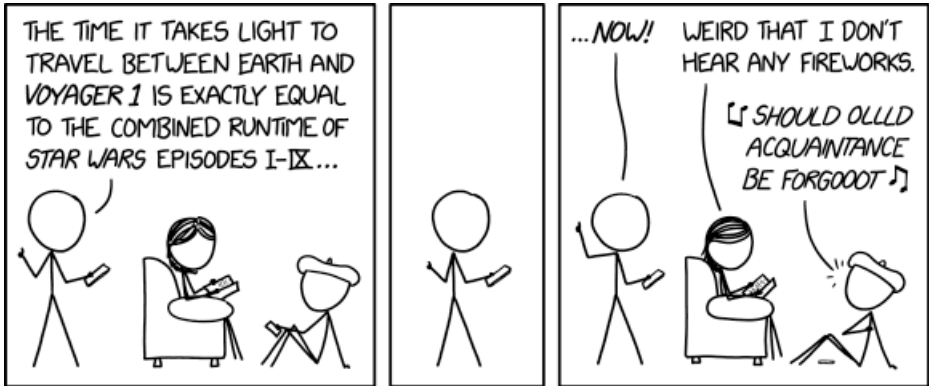
Popeye the Sailor is a cartoon character created in 1929, and has been adapted for feature film, television, comic

books, and other media. Popeye the Sailor is the best-known character named "Popeye", so it is a little unusual that Randall would have to clarify which Popeye he is referring to. Other Popeyes include Jimmy "Popeye" Doyle from *The French Connection* and the criminal Popeye from William Faulkner's novel *Sanctuary*. Like "Sonic", there is a restaurant chain named "Popeyes", which is the second-largest fast-food chicken restaurant chain in the world (after KFC).

The title-text alters the pattern slightly by discussing the Battle of Midway (i.e. the X of Y). This case has additional humor because Randall clarifies which battle he is talking about, but not which of the several movies depicting the battle (although he was most likely referring to the film released in November 2019, simply called *Midway*).

## #2253: Star Wars Voyager 1

January 10, 2020



There's some flexibility depending on your standards for measuring runtime and the various special editions. If you still want to have a party, I'm sure you can find some combination that works.

## Explanation

Cueball has added together all the runtimes of the Star Wars movies (episodes I-IX) and then calculated the exact time at which a message sent to Voyager 1 will have that exact duration in light speed delay. He announces this information to Megan and Beret Guy only seconds before it occurs, allowing him to signal the moment by saying "Now!", after waiting in the beat panel.

Megan expresses surprise that the event isn't being celebrated with fireworks. Judging by the fact that she doesn't look up from her book, her surprise is sarcastic. Beret Guy breaks into song with the New Year's traditional "Auld Lang Syne", traditionally transcribed as "Should auld acquaintance be forgot" but here rendered with a non-Scots attempt at the song's orthography.

This comic highlights an interesting relationship between the Star Wars episodes and the NASA space probe "Voyager 1", which most likely no one else has thought about, but most likely fitting well with fans of both xkcd and Star Wars.

The original Star Wars film was released on May 25th, 1977, only four months before Voyager 1 was launched on September 5th, 1977. The last film was released more than 42.5 years later on December 20th, 2019, only three weeks before this comic.

Voyager 1 was, with a distance of 148.68 Astronomical

units (22.2 billion km; 13.8 billion mi) from Earth as of December 26, 2019, the most distant human-made object from Earth. This data is given with reference in the Wikipedia article for Voyager 1. That was less than a week after the release of the new movie. That is approximately 20.6 light hours away. With the recently released last episode the total viewing time of the nine episodes is 20.35 hours (not including the spin-off movies). So a discrepancy of 15 minutes. This could be explained by the title text.

In the mission status of the two Voyager probes there were a One-Way Light Time of 20 hours 36 minutes and 46 seconds on the day the comic was released. This corresponds to 20.613 light hours, only the 46 seconds deviation from exactly 20.6 hours.

This is an odd coincidence that Cueball/Randall saw significant enough to mark with a timer and acknowledgment to Megan and Beret Guy (and the rest of the fans of xkcd).

In the title text Randall notes that there can be different ways of measuring run times, both if you do not count credits into the runtime or with more than one version existing of at least the original trilogies films, with added extra footage. This means that if you choose the longest possible run time, you may still have a chance to throw a party for some time to come, as every extra minute of film will add time before Voyager 1 reaches that extra light minute.



However as demonstrated in the Table of runtime below, then only for the very longest versions would this have worked around the time of the release of the movie. Now, three weeks later it is too late.

When Voyager 1 left the heliosphere it was traveling at about 17 kilometers per second (11 mi/s), making it the fastest heliocentric recession speed of any spacecraft, and it is not really slowing down. (Do note that the speed with which it travels from Earth is not the same since Earth is in orbit around the Sun and sometimes travels faster towards Voyager 1 than Voyager 1 leaves the sun, but then Earth turns and goes the other way!)

Since a light minute is  $1.799 \times 10^7$  kilometers it takes Voyager 1 12.25 days to travel this far. So for every minute added to the run time, the party start time will be delayed by more than 12 days. However, it is already 14 days since the distance given on Wikipedia, so more than one extra minute is needed to postpone the party to after the release day of the comic.

The last possible chance is to assume that all run times have been rounded down, which could add anywhere from a half a minute to almost 9 full minutes if they round 125.9 down to 125, and not only rounded 125.4 (and not rounding 125.5 up). Actually, assuming all runtimes are rounded down, it is realistic that there is on average half a minute extra runtime per episode making 4.5 minutes extra time. This would buy 55 extra days from the 26th of December... But to find this out correctly, someone would need to review all the 9

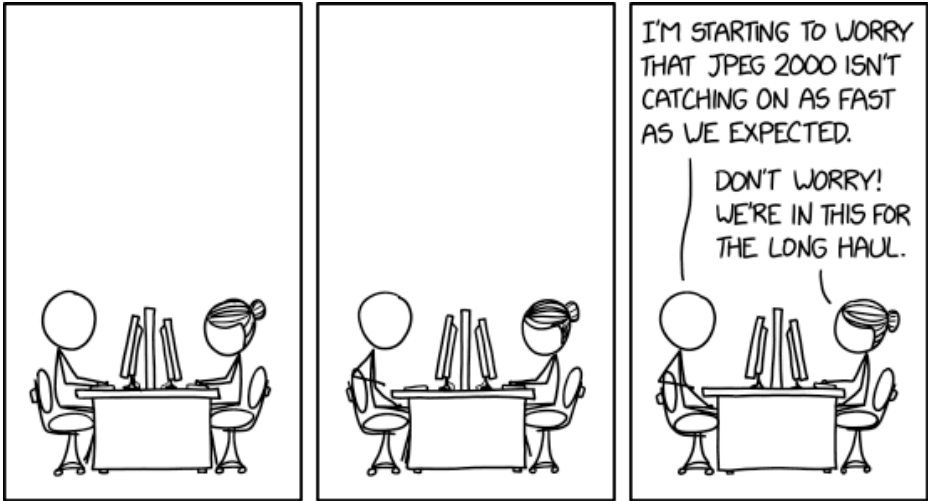
episodes from the very first second to the very last of the most extended versions. It seems that it could still be possible to find a day where the party can still be held after the release day of the comic.

In the extreme case that all movies went 59 seconds over a full minute, but all times are rounded down, it would add 8 minutes and 51 seconds. This could give 108 extra days from 2019-12-26, meaning that Easter Sunday 2020 (2020-04-12) would be the last possible day for such a party.

This may also be a play on the confusion between the Star Wars and the Star Trek franchises. In the case of Star Trek, the very first movie dealt with a Voyager probe (Voyager 6 in this case), and the number of hours and quantity of Star Trek movies rivals and exceeds that of the main Star Wars movies; about 25 and a half hours between 13 movies. Maybe we'll see this in an xkcd when Voyager gets a little further away?

## #2254: JPEG2000

*January 13, 2020*



I was actually a little relieved when I learned that **JPEG2000** was used in the **DCI** digital cinema standard. I was feeling so bad for it!

## Explanation

JPEG2000 is a standard for digital image storage created by the Joint Photographic Experts Group from 1997 to 2000 to improve on the original JPEG standard, published in 1992. The original JPEG standard is the most widely used image format in the world for both digital cameras and the World Wide Web, while the newer and improved JPEG2000 standard is relatively rare. As of 2020, it is supported by Photoshop, the Safari browser, and GIMP, but it remains unsupported or poorly supported by other popular software, including Google Chrome and Mozilla Firefox browsers. Meanwhile, competing format WebP which appeared 10 years later is supported in all major browsers and has much wider support in other applications as well.

As a result, the conventional file name extensions for files using the JPEG2000 standard, .jp2 and .jpx, remain unfamiliar to many users while the .jpg extension, denoting the original standard, is well known.

The JPEG2000 standard was seen as an improvement by its creators, supporting many features not included in the original standard, such as multiple resolutions, progressive transmission, a lossless compression option, and alpha channel transparency. The complexity of fully implementing the standard, as well as patent concerns, may have slowed adoption.

Cueball and Hairbun seem to have some desire for or stake in JPEG2000 adoption. Cueball begins to worry

after more than 20 years without much progress but Hairbun is confident that it will eventually prevail, and she cares more about its eventual use than rapid adoption.

The core concept of this comic is that engineers often expect that a superior technology or standard will catch on, though often other factors keep an "inferior" standard dominant. (See various comics referencing Dvorak keyboards, as well as the term "betamaxed.")

The "we are in this for the long haul" statement might refer to the engineers believing that superior technology will eventually win despite the evidence to the contrary. Its humor comes from the fact that as of the comic publication in 2020, JPEG2000 shows no sign of becoming a widely-used standard.

The title text suggests that Randall feels bad that the standard hasn't been adopted, perhaps because he empathizes with the engineers who worked hard to develop it or anthropomorphizes the standard itself, which has been ignored by most of the computer-using world. Also he may actually believe it is the better standard that should have been more widely used. DCI, short for Digital Cinema Initiatives, is a collaboration of several major film studios to establish standards for the security and proper display of digital films. Version 1.0 of the DCI's "Digital Cinema System Specification" was released in 2005.

## #2255: Tattoo Ideas

January 15, 2020

### TATTOO IDEAS

~~LOREM IPSUM TEXT~~

~~EMAIL PASSWORD~~

~~GRAPH OF THE POPULARITY OF TATTOOS  
OVER TIME, WITH THE DATE I GOT THE  
TATTOO MARKED (UPDATE REGULARLY)~~

~~"CHANGEME"~~

~~SLIDE RULE MARKINGS ON FOREARMS~~

~~EURION CONSTELLATION, SO NO ONE  
CAN PHOTOCOPY PICTURES OF ME~~

~~THE SENTENCE "IT'S WHAT MY TATTOO  
SAYS" WRITTEN IN ANOTHER LANGUAGE~~

~~TISSOT'S INDICATRIX~~

~~SUMMARY OF THE SNOOPES PAGE ON THE  
TATTOO EPIDURAL THING (LOWER BACK)~~

~~PRE-SURGICAL CHECKLIST~~

~~TATTOO ARTIST'S SOCIAL SECURITY NUMBER~~

~~BOARDING PASS FOR AN UPCOMING FLIGHT~~

~~RECAP OF THE PLOT OF MEMENTO~~

THIS LIST, IN ITS ENTIRETY

The text ALL YOUR BASE ARE BELONG TO US with a lengthy footnote explaining that I got this tattoo in 2020 and not, as you may assume, 2001, but offering no further clarification.

## **Explanation**

This comic is a list of potential tattoo ideas. Many of them play on the trope of regretting a tattoo by being tattoos of things that would not be useful outside of the immediate future, while others are simply ludicrous ideas with little functionality.

A tattoo by nature is designed to be permanent and difficult to change or remove. A lot of the jokes below describe things that are designed to be impermanent and/or change frequently.

**Table of entries**[\[edit\]](#)

## #2256: Bad Map Projection: South America

*January 17, 2020*



BAD MAP PROJECTION #358: OOPS, ALL SOUTH AMERICAS!

The projection does a good job preserving both distance and azimuth, at the cost of really exaggerating how many South Americas there are.



## Explanation

This is the third comic in the Bad Map Projections series displaying Bad Map Projection #358: Oops, all South Americas!. It came almost three years after the second 1799: Bad Map Projection: Time Zones (#79) (3 years after the first). It was followed a year and a half later by 2489: Bad Map Projection: The Greenland Special (#299).

The comic shows a map projection in which every continent and large island has just been replaced with a differently scaled and rotated version of the continent of South America, even though there is only one South America in the real world.[citation needed]

By overlaying this map with the selection of map projections presented in 977: Map Projections, it seems that the "underlying" projection used here is the Winkel tripel projection, also used in 2242: Ground vs Air.

The comic is similar to joke map designs in which continents like Africa and South America have been swapped, or where someone will jokingly replace Greenland with South America.

The caption of the comic is a reference to the Cap'n Crunch cereal type that became a meme, Oops! All Berries, which has also been referenced in 2719.

Interestingly on the original South America, the archipelago or main island (hard to tell) of Tierra del

Fuego is replaced with a small South America. In contrast, all other South Americas, including the one replacing the Tierra del Fuego, include it in their shape.

The title text claims that the map projection does a good job preserving distance and azimuth, the joke being that the distance and azimuth being preserved for the non-South America continents are those of South America and not the original continent. Note that for the map as drawn in the comic, while this is true for most of the larger landmasses, many of the smaller South Americas are distorted more significantly (such as the South Americas that replace New Zealand).

From roughly left to right and top to bottom, the South Americas replace:

- North America
- 3 SAs for the Canadian Arctic Archipelago (possibly Victoria Island, Ellesmere Island, and Baffin Island)
- Greenland
- Iceland
- Ireland (Republic of Ireland and Northern Ireland, UK)
- Great Britain, UK
- Eurasia
- Newfoundland, Canada
- 2 SAs for Hokkaido and Honshu, Japan
- Africa

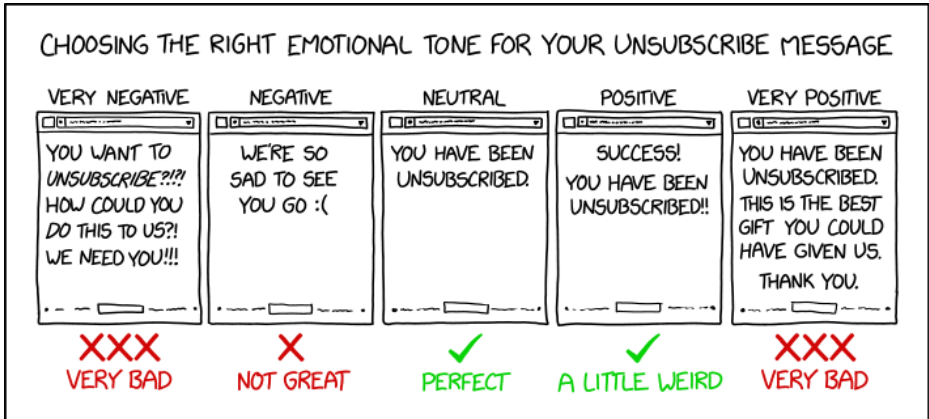
- Taiwan
- Cuba
- Hispaniola (Dominican Republic and Haiti)
- Puerto Rico, US
- Jamaica
- Sri Lanka
- 5 SAs for Luzon, Bicol Peninsula (southeastern Luzon), one ambiguous landmass (possibly Negros Island), Samar, and Mindanao; Philippines
- Sumatra, Indonesia
- Borneo (Indonesia, Malaysia, and Brunei)
- Sulawesi, Indonesia
- 2 SAs for New Guinea: one for Bird's Head Peninsula in the northwest of the island, and one for the rest of the island
- Java, Indonesia
- Madagascar
- Australia
- Tasmania, Australia
- 2 SAs for South Island and North Island, New Zealand
- Isla Grande de Tierra del Fuego, Argentina and Chile

These are the 26 largest non-Antarctic landmasses, plus 2 peninsulas of those landmasses, and 8 more islands.

See also related comics with map changes in comics 1500: Upside-Down Map and 1653: United States Map.

## #2257: Unsubscribe Message

January 20, 2020



A mix of the two is even worse: 'Thanks for unsubscribing and helping us pare this list down to reliable supporters.'

## Explanation

When a website offers a subscription service (e.g., an email newsletter), they will offer the opportunity to unsubscribe from the service in the event that the subscriber is no longer interested in the service, or discovers that the service is not what they thought it was. As with any online process, subscribing and unsubscribing require messages to inform the viewer that the process has completed as intended. Some sites also request confirmation when unsubscribing, to prevent accidentally unsubscribing due to a mistyped URL or a misclicked link.

This comment explores the different "moods" that unsubscribe messages can carry, taking standard examples and pushing them further than is normally seen. It also pokes fun at the trend for websites to guilt users when they unsubscribe (or try to guilt them out of it before they complete the process), which is widespread among new-age website design and some examples of which can be seen at [/r/Clickshaming/](#). The first example appears to be a message in the confirmation phase, while the others are messages that the unsubscription is complete.

The first message is of a "very negative" mood, where the "confirmation" message begs to know why the user dared to unsubscribe to the service, sounding either very angry or alarmingly desperate, as if the service is endangered by the user's unsubscribing. This can be very off-putting

and would be very likely to confirm to the user that they made the right choice; hearing such an aggressively needy tone when they leave could make them feel like they escaped something instead, and thus it is given three red X marks and ranked "Very Bad".

The second message is of a more controlled "negative" mood; the "process complete" message tells the viewer that they will be missed with a sad emoticon accompanying it. Although not quite so bad as the forceful clinginess of the "very negative" message, this one can still come across as an attempt to guilt the user into re-subscribing; thus it is rated with one red X and the label "Not Great".

The third message is of a fully "neutral" mood; the "process complete" message is simply a matter-of-fact statement that the user has been successfully unsubscribed from the service. Randall seems to consider this the optimal mood for an unsubscribe message to carry; thus it is rated with a green check mark and the label "Perfect".

The fourth message is of a "positive" mood; the "process complete" message cheerfully proclaims that the attempt to unsubscribe has been completed. This is the most common mood for many services that attempt to avoid emotionless, robotic messages; however, in this particular instance, it can come across as somewhat unnerving, since no service should seem happy to see a user leave. The tone also comes across like a proclamation of the sort you would see in a video game text box, making the

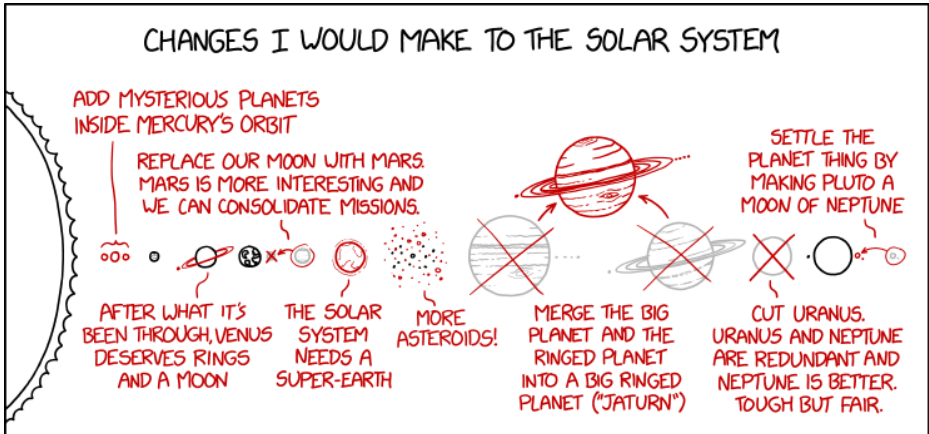
action feel like an achievement, which wouldn't make sense for a company to do. This mood is rated with a green check mark, but also with the label "A Little Weird".

The fifth message is "very positive", where the "process complete" message expresses relief that the user has chosen to unsubscribe from their service, as though their subscription in the first place had been some sort of burden upon the service, and indeed, their leaving is stated to be the best thing to happen to the service. Like the "very negative" message, this response is likely to assure the user never returns, since they have been indirectly insulted and told "good riddance".

The title text expands on the joke by combining the positive reaction to unsubscribing with a more negative tone, which supports the user's choice to unsubscribe because they were unwanted. This references the 1% rule, which states that for users of an online service only approximately 1% will be significantly active.

## #2258: Solar System Changes

January 22, 2020



"Actually, Jupiter already has a very impressive ring system!" --someone who knows Jupiter is within earshot



## Explanation

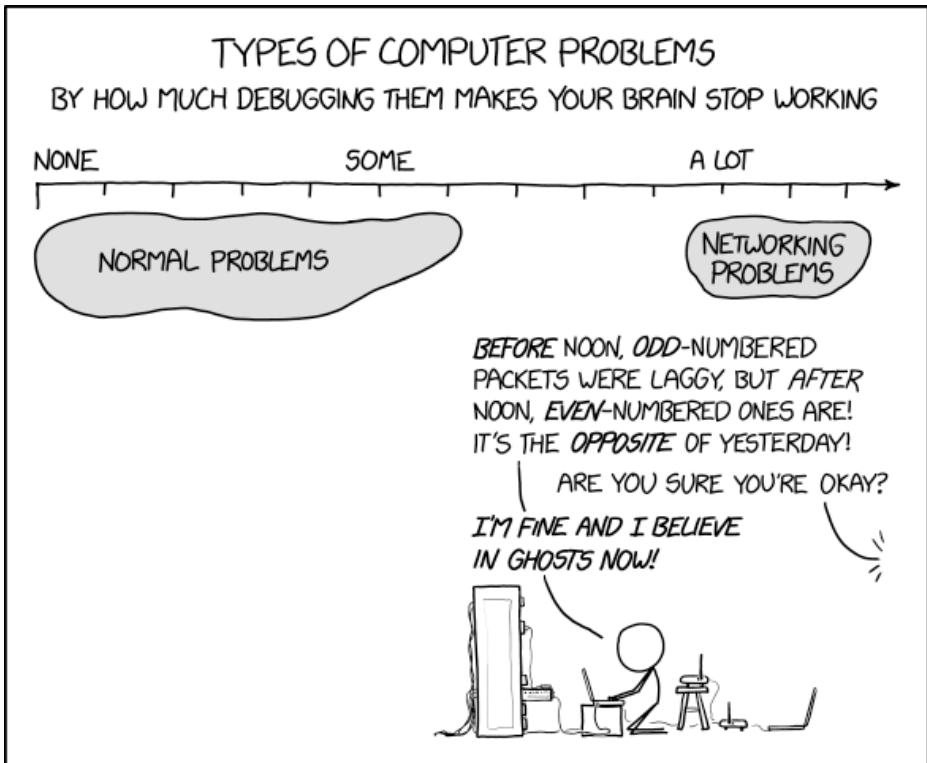
This comic shows a drawing with a standard sketch of the Solar System, featuring the Sun, 8 planets, the asteroid belt, and Pluto. Randall then proposes eight changes to the solar system that he would make if he had the power to do so. Each change is drawn in red with explanatory labels. Performing these changes would be impossible in practice[citation needed] and would probably make the solar system unstable if actually performed.

This is another comic containing red annotations over a complex and established structure.

The title text is being spoken by "someone who knows [that] Jupiter is within earshot," implying that the speaker does not wish to offend Jupiter. While Jupiter does have its own ring system, it is so faint that it wasn't discovered until 1979. Considering that Jupiter is known to disrupt the asteroid belt and send asteroids towards the inner solar system (cf. Kirkwood gap) and completely destroy other celestial bodies (Comet Shoemaker–Levy 9), someone who is "within earshot" of Jupiter may wish to reassure the planet that they think its ring system is already very impressive when they really don't.

## #2259: Networking Problems

January 24, 2020



LOOK, THE LATENCY FALLS EVERY TIME YOU CLAP YOUR  
HANDS AND SAY YOU BELIEVE

## Explanation

Computer problems are frequent and can be difficult to solve.[citation needed] Networking problems in particular can puzzle even seasoned people and sometimes seem to have arbitrary issues causing them. Packets are units of data transfer used in computer networking. One measure of network performance is lag, or the more technical term of latency, which describes the amount of time it takes for data to travel from one point to another (and perhaps back); saying a packet's transmission is 'laggy' means it is unacceptably delayed. Suffering from lag means that you're likely exhibiting various knock-on effects, from intolerable online gaming experiences to difficulties streaming multimedia resources, with or without the simultaneous issue of having low bandwidth.

Lag in packet transmission and other network performance measures can appear quite random. Just to start with, your ISP may be engaged in traffic shaping, which can do very weird things indeed to your packets (making the first megabyte of a transfer faster than any other, for example); now imagine that your ISP's ISP (usually known as an "Upstream Provider") is engaged in something similar, and you begin to see the scale of the problem. Wireless latency can relate to things as unexpected as where people are standing, what they are touching, the weather, viruses and other system compromises, network activity by other unseen users, and so on. Because humans are wired to perceive

patterns, they will find them even in random data, a fallacy that Cueball is probably suffering from here. He variously attributes the network behavior he sees to the packet number being even vs. odd, packet arrival time being before vs. after noon, and packet arrival day being today vs. yesterday. Such a pattern would make sense if it were merely "every other packet" regardless of odd or evenness, but that still leaves unexplained the other "patterns" Cueball is seeing (for which the explanation may involve a scheduled process that runs daily at noon and transmits or receives an odd number of errant packets).

These non-existent patterns that Cueball is 'finding' are driving him mad, so much so that he says he believes in ghosts now. The statement of belief in ghosts may be a reference to the intermittent or fluctuating nature of the network issues being caused by mischievous or malevolent spirits. Ghosts generally are not concerned with expressions of belief, but there are some religious traditions that include group clapping and chanting. Many works of fiction depict a future or alternate history where machines are worshiped as gods or spirits, such as the Adeptus Mechanicus of Warhammer 40,000. Some of this terminology can be found in present-day IT and other support personnel, including references to "daemons" and "black magic". Another possible reference Randall may be making is to the Ghost in the machine, a term describing AI. A third possibility is that Cueball's brain had stopped working, as Randall had suggested in his chart. it may also be a reference to 1316:

Inexplicable, in which Megan concludes Cueball's computer is haunted.

The title text continues Cueball's maniacal attempts at self-assurance, with him alluding to J.M. Barrie's play Peter Pan by saying that latency falls every time you "CLAP YOUR HANDS AND SAY YOU BELIEVE". In the play, Peter Pan says, "Say quick that you believe! If you believe, clap your hands!" A more mundane explanation of the network behavior Cueball is experiencing might be that it is random but he's seeing a pattern anyway, or that there is a loose connection or trace and the vibration of clapping and speaking in the vicinity of the equipment in question closes the connection.

Similar superstition regarding computer devices was used previously in 1457: Feedback.

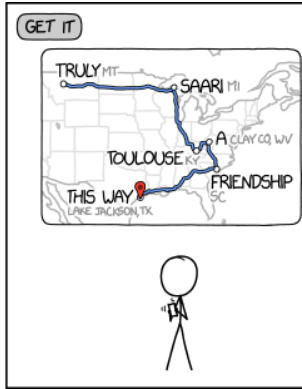
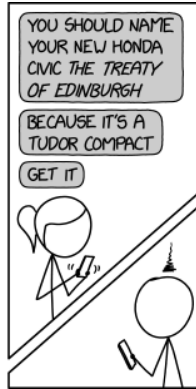
## #2260: Reaction Maps

January 27, 2020

TEXTING TIP  
—  
IS YOUR REACTION  
TOO INTENSE TO  
BE EXPRESSED IN  
AN EMOJI OR GIF?

TRY USING  
DRIVING  
DIRECTIONS!

THE EXTRA  
RESEARCH IT  
REQUIRES SHOWS  
HOW STRONGLY  
YOU FEEL.



If Google Maps stops letting you navigate to (Clay County District) A in West Virginia, you can try Jump, OH -> Ina, IL -> Big Hole, TX.

## Explanation

This is another one of Randall's Tips, this time a Texting Tip.

Randall suggests that readers send a set of driving directions as an intense / extremely annoyed response (a "Reaction Map", named after the "Reaction Face", "Reaction Gif", and other memes). The words "Reaction Map" in Chemistry refer to a diagram that shows how compounds react to form different compounds; an example can be found [here](#).

In this comic, Ponytail texts the following car pun/joke:

The Treaty of Edinburgh was a treaty drawn up in 1560, which falls during the Tudor period of the history of England, while a compact is another word for a treaty -- hence a Tudor compact. A Honda Civic is a compact car, which has a coupé body model with only two doors (there are also hatchback and 4-door sedan versions) -- hence a two-door compact. The joke is thus a double pun on the similarity of the words "Tudor" and "two-door", as well as a pun on the words "treaty" and "compact."

Pronouncing "Tudor" as "Tyoo-dor" (i.e. without American-style yod-dropping) rather than "Too-" may hinder comprehension of this pun.

Puns rise and fall in popularity, and some people dislike them at all times. Recipients often groan, sometimes even

while laughing or smiling. Because of this pun, Cueball gets so mad at Ponytail that he replies twice, first that their friendship is over and second that he hopes she falls in a lake. Both times he uses driving directions to do so because he wishes to show how mad he is by spending time finding cities with relevant names just to do it.

The list of map destinations, Truly (MT), Saari (MI), Toulouse (KY), A (WV), Friendship (SC), This Way (TX) is a way of saying, "Truly sorry to lose a friendship this way".

The list of map destinations, Hope (NY), Yoe (PA), Fallin Lake (AR) is a way of saying, "Hope you fall in [a] lake".

"A" is one of the three districts in Clay County, WV. The others are "B" and "C".

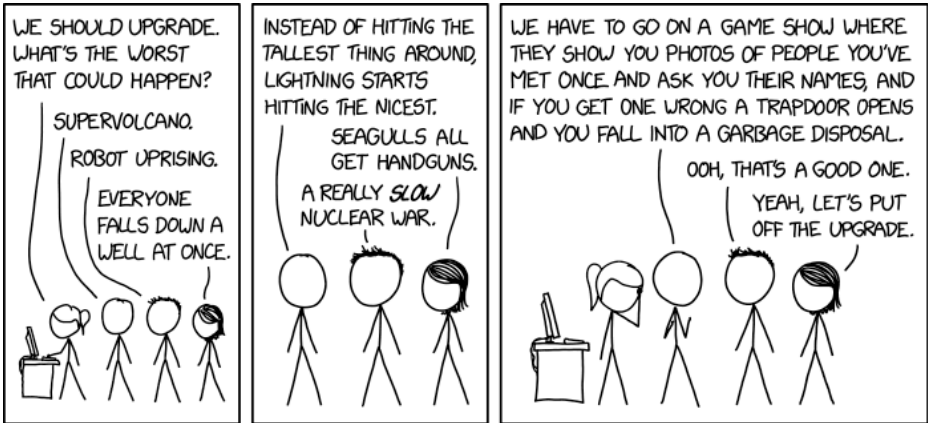
In the title text, Randall offers a different option if "A" is removed from Google Maps, Ina (IL), to make this response: Jump (OH), Ina (IL), Big Hole (TX) ("Jump in a big hole".)

In 2245: Edible Arrangements, Cueball was irritated by a pun from Megan which was also themed on English history ("Vore of the Roses"), but in that strip, he evidently didn't get angry enough to send a map expressing that he would "Cancelada Arrangements" he had bought for her -- he simply told her so in person and then walked away when she kept punning.



## #2261: Worst Thing That Could Happen

January 29, 2020



Before I install any patch, I always open the patch notes and Ctrl-F for 'supervolcano', 'seagull', and 'garbage disposal', just to be safe.

## Explanation

Ponytail and her friends are considering upgrading some part or program of their computers. They may feel the need to upgrade because the software they are currently using has some vulnerability that is only patched in newer revisions (this comic was released just two weeks after the end of extended support for Windows 7), or because they want to have access to some new feature. As part of the decision-making process, Ponytail asks her friends, "What's the worst that could happen?" If the computers they are discussing are privately owned, she may be concerned about losing personal data or having to learn new software interfaces. On the other hand, if they are discussing a corporate computer system, there may also be business-related risks. If their company relies on functionality offered by their current system that has been deprecated or modified in the updated version (such as in 1172: Workflow, or as with many specialized tools or machines in the real world), they may suffer downtime while they modify the rest of their workflow. Even if the upgraded system should continue to fit their needs, they may need to take some downtime to perform the update and deal with the risks of something going badly along the way, and there may be major costs associated with license subscriptions and support contracts. "What's the worst that could happen?" is also a common rhetorical question; Ponytail may be expressing a belief that nothing bad could happen as a result of the upgrade, and not expecting an answer.

Unfortunately, Ponytail's friends answer with their ideas for the worst things that could happen ever, not as a result of the upgrade, as Ponytail meant, or they are taking the question to the logical extreme and invoking chaos theory. The result is a list of "worst things" ridiculously unconnected to a computer upgrade. At the end, however, Megan interprets these as possible results of the upgrade, and advises against upgrading. A list with explanations can be found below. Ponytail facepalms at her friends' overly-literal senses of humor.

Alternatively, Ponytail could be facepalming at the fact that the worst thing which could happen, according to her team, is that they are put on a ridiculous game show in which, if they answer a question incorrectly, they are chucked in garbage disposal. This may be bad, but it is nowhere near as bad as an erupting supervolcano or nuclear war.[citation needed] However, Cueball has shown anxiety and difficulties in social situations, such as the less-than-helpful advice in 1917: How to Make Friends, so he (and likewise Hairy and Megan) may consider that embarrassment on the game show (which might then be immortalized online) is worse than instantaneous death in a nuclear war.

Megan and Cueball have previously experienced a severely-botched upgrade in 349: Success, in which Cueball somehow caused them to end up in shark-infested waters off the coast of a deserted island when he was just trying to get their computer to dual-boot BSD.

The title text talks about searching upgrade release notes for some of the things listed to be sure none are potential side effects of an upgrade. "Ctrl-F" is a common keyboard shortcut for "find text string" in many programs. Since Randall is just reading but not changing the patch notes, a web browser, PDF viewer, or word processing program such as Adobe Reader or Microsoft Word might have been used.

### **List of worst things[edit]**

- The list of "worst things that could happen" discussed by the team are:

## #2262: Parker Solar Probe

January 31, 2020

LOOKING DOWN  
TOWARD THE SUN  
AND THE  
PARKER SOLAR PROBE.  
(DISTANCES ARE TO SCALE.  
SIZES ARE NOT TO SCALE.)



It will get within 9 or 10 Sun-diameters of the "bottom" (the Sun's surface) which seems pretty far when you put it that way, but from up here on Earth it's practically all the way down.

## Explanation

This is an informative comic meant to represent the relative distances of astronomical objects relative to the Parker Solar Probe. It also shows where the probe will be in 2025 if its mission continues going according to plan. As explained by the caption at the top of the image, the distances between entities on the chart is drawn to scale; the sizes of said entities, however, are not, which is humorously showcased front-and-center by Cueball and Megan being shown as Earth-sized.

The Parker Solar Probe is a robotic spacecraft launched by NASA in 2018 with the mission of repeatedly probing and making observations of the outer corona of the Sun. It travels in an elongated orbit that passes close to the Sun and sometimes passes near Venus, arranged such that Venus nudges the orbit slightly in each pass to bring the probe's perihelion (the lower end of its orbit) closer and closer to the Sun. Two days before this comic was published the probe again passed through perihelion, establishing new records for closeness to the Sun (0.12 AU) and speed (244,225 mph). By the end of the probe's planned lifetime in 2025, it will pass within 0.046 AU (6.9 million km), or about 5 solar diameters, of the Sun's center, at a speed of 430,000 mph (690,000 km/h). The title text incorrectly states this distance to be 9 or 10 solar diameters measured from the Sun's surface.

Helios 2 was a solar probe launched in the 1976 that formerly held the records for closest man-made object to

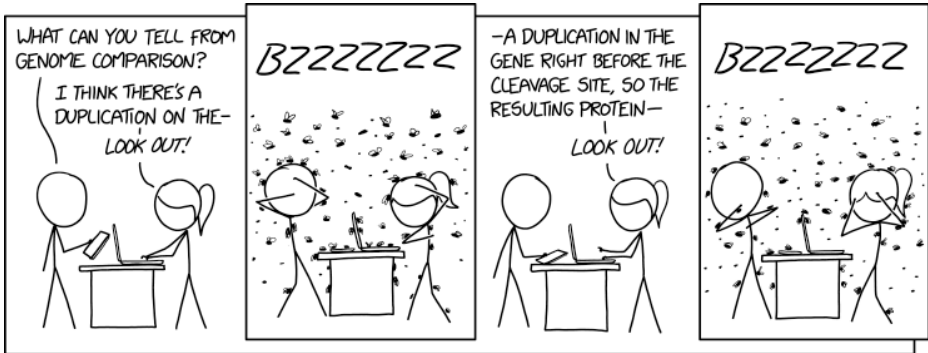
the Sun and fastest man-made object. Both records were surpassed by the Parker probe in 2018.

Cueball and Megan are standing on Earth. The way this diagram is drawn, they look like they could fall off Earth toward the Sun -- hence the comment "Careful!" -- though the joke is that in real life they would fall toward the center of the Earth, not toward the Sun. Also the surprise for many people is that it is much harder to reach the Sun than Pluto, because we travel so fast here on Earth. To reach the Sun this speed has to be reduced, which is a larger speed difference than the one needed to escape the Sun's gravity well. If you could "fall" off Earth, you would just keep the approximately same distance to the Sun, but drifting slowly away from Earth.

The title text says the probe will get within 9 or 10 Sun-diameters of the Sun's surface. This is a bit of a mistake: it will actually get within that many Sun-radii (only  $4\frac{1}{2}$  or 5 Sun-diameters) of the center of the Sun, which corresponds to 4 or  $4\frac{1}{2}$  Sun-diameters above its surface. All the same, the title text makes the point that "Sun-diameters" (or "Sun-radii", for that matter) sounds like an astronomical distance, until you use the same scale for other distances. The distance from the Earth to the Sun is approximately 106 Sun-diameters; by that scale, 4 Sun-diameters is indeed "practically all the way down". Below is a table showing these and other distances using more common units of measurement.

## #2263: Cicadas

February 03, 2020



OUR GENETICS WORK HAS PRODUCED 17-SECOND CICADAS,  
BUT WE'RE HAVING A HARD TIME FIGURING OUT HOW.

After a while you adjust to the new cicadian rhythm.



## Explanation

Cicadas are a species of insect whose nymphs burrow underground and emerge as adults to reproduce several years later. One common species in North America is the 17-year cicada, also known as the periodical cicada. These cicadas form distinct broods which burrow and emerge as a group every 17 years, with different broods starting the cycle at different times. This results in a couple of weeks every 17 years when the cicadas swarm in huge numbers, then vanish just as quickly when the adults die off. Cicadas also make a distinctive buzzing sound, which makes their periodic appearance even more memorable.

In the comic, Cueball and Ponytail have accidentally created 17-second cicadas using genetic engineering. This means that rather than seeing a massive swarm every 17 years that lasts for a few weeks, they have to deal with a swarm every 17 seconds that lasts for a few moments. This makes it very difficult for them to do their work, especially to figure out how the cicadas were created because the swarm keeps interrupting their work. Note that the comic has been drawn differently to most other straight four-panel comics, probably to highlight the interruptions of the buzzing swarm - see the transcript. Also see the trivia section below for more details on the 17-year cicadas. Those were referenced again in the title text of 2633: Astronomer Hotline.

It's worth noting that every 17th word in the comic is

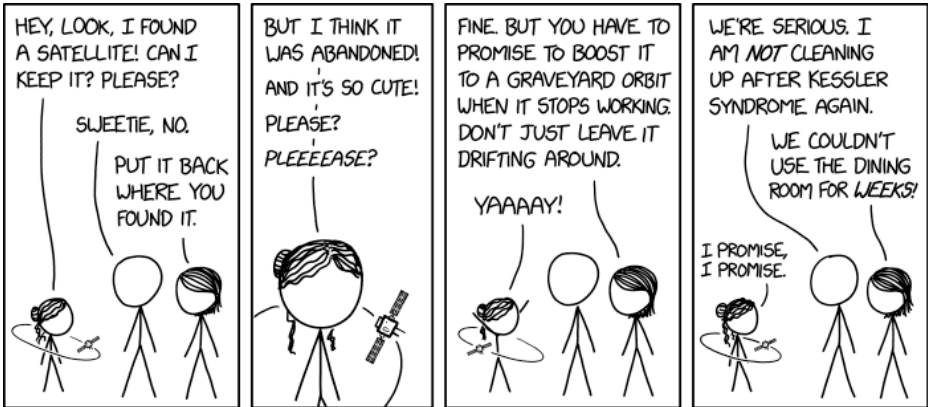
"bzzzzzzz", implying that every word spoken takes one second. The caption also includes 17 words (if "17" is one word).

The title text is a pun on "circadian rhythm." In particular, it might resemble something said to someone getting adjusted to a new sleep schedule. But here it is the 17 seconds interruption, not a time zone shift, that has to be adjusted for.

This entire comic seems to only have been a lead-up to the "circadian rhythm" punchline. This is an interesting suggestion since Randall has mentioned in an interview that he makes up the title text after completing the comic.[actual citation needed] Seems like he made an exception here; unless he didn't.

## #2264: Satellite

February 05, 2020



If you're going to let it burn up, make sure it happens over the deep end of the bathtub and not any populated parts of the house!

## Explanation

This comic humorously compares the relationship between humans and satellites to the relationship between humans and pets. "He followed me home, can we keep him?" is a stock phrase said by children pleading with their parents to keep a "found" animal as a pet. The stock response is to admonish the child to look after the pet's needs, especially the less fun ones, like cleaning up after the pet. In this comic, Jill wishes to adopt an "abandoned" satellite, but rather than being asked to clean up after the satellite's waste, she is lectured by her parents on how to properly discard it once it stops working. This would be like saying "you have to promise to bury the dog in the backyard when she dies, not leave her corpse to decompose in the dining room like the last one," which is not how most pet-adoption conversations go.[citation needed] A similar theme of humans being orbited by fun-sized space objects is featured in 1300: Galilean Moons.

A graveyard orbit is an orbit far away from operational satellites. Graveyard orbits are used when a satellite is far enough away from the Earth that de-orbiting it into Earth's atmosphere is too expensive to be practical. The most widely used graveyard orbit is approximately 300 km above geostationary orbit; a satellite at the end of its life will briefly accelerate to move further away from Earth, so Jill's parents refer to "boosting" the satellite into a graveyard orbit.

Kessler syndrome is a proposed scenario in which satellite collision(s) produce many pieces of orbiting space junk, which then hit other satellites and create even more pieces of junk, which hit more satellites, and so on. In this scenario Earth becomes surrounded by so much man-made debris that the risk of a collision makes space activities functionally impossible, without advanced techniques being employed to avoid, destroy, or neutralize the debris. Apparently, Jill has caused this scenario before in her parents' home, requiring extensive cleanup of the dining room and making it unusable for weeks. Kessler syndrome was the premise of the movie *Gravity*, where the collision of two satellites produces pieces of shrapnel that go on to tear apart other satellites including the International Space Station and a Space Shuttle. A variation of Kessler syndrome was the focus of the first part of the Neal Stephenson novel *Seveneves*, where cascading collisions of fragments of the moon led to natural and artificial debris fields around the Earth.

The title text is more advice from Jill's parents. They tell her that if she is going to let her satellite reenter the atmosphere and burn up, she should do it above the deep end of the bathtub. This echoes how satellites in orbit can be purposefully de-orbited and are usually planned so that any debris that isn't fully destroyed lands in the ocean and does not pose a safety risk. When it is possible, satellites are generally directed towards the South Pacific Ocean Uninhabited Area, commonly known as the "spacecraft graveyard", to land over a thousand miles away from any populated landmass.

Two defunct satellites had a near miss on January 29, 2020, the week before this comic strip was published, possibly serving as the inspiration for this strip. This is becoming more of an issue, especially in Low Earth Orbit, as more and more satellites are built, and old satellites become defunct.

## #2265: Tax AI

*February 07, 2020*

YOU MAY CLAIM UP TO 1040  
DEFENDANTS ON YOUR SEITAN  
LOCAL INCOME TAX FOR FISCAL  
YEAR 20202 BY TAKING THE  
STANDARD DEDUCKLING AND  
ATOMIZING YOUR CLAMS.



I USED A NEURAL NET TO PREPARE  
MY TAX RETURNS, BUT I THINK I  
CUT OFF ITS TRAINING TOO EARLY.

I ended up getting my tax return prepared at a local  
place by a really friendly pretrained neural net named  
Greg.

## Explanation

The deadline for filing tax returns in the United States is April 15, so many people in the US are already in the process of filing their taxes at the time of this comic's publication. Traditionally, people used tax provider companies, but it is becoming more popular to use tax preparation software, such as TurboTax or a service from the Free File Alliance, which helps to fill in the tax forms after a user enters their income information and deductions for the year.

In this comic, Cueball has attempted to train an artificial neural net to prepare his US tax return, but it has made several comical errors, purportedly because it was not trained extensively enough. Most of the errors consist of malapropisms, words that sound almost the same but mean very different things switched for comic effect. This suggests Cueball trained the neural net by talking to it.

The title "Tax AI" can be considered a pun, either referencing the AI software Cueball just trained to prepare his tax return, or an exhortation to tax AI entities, as a possible slogan supporting Robot tax.

The title text references 2173: Trained a Neural Net, which indicates that getting a human to do something is basically using a "pretrained neural net". Cueball has chosen to use a local tax provider to help him file his taxes, aka a "pretrained neural net" in the form of a



human named Greg.

Randall also "trained" humans to do his tax returns in 1566: Board Game. Tax returns and the troubles of filling them out were also the subjects of 1971: Personal Data and 1977: Paperwork.

## **Types of errors[edit]**

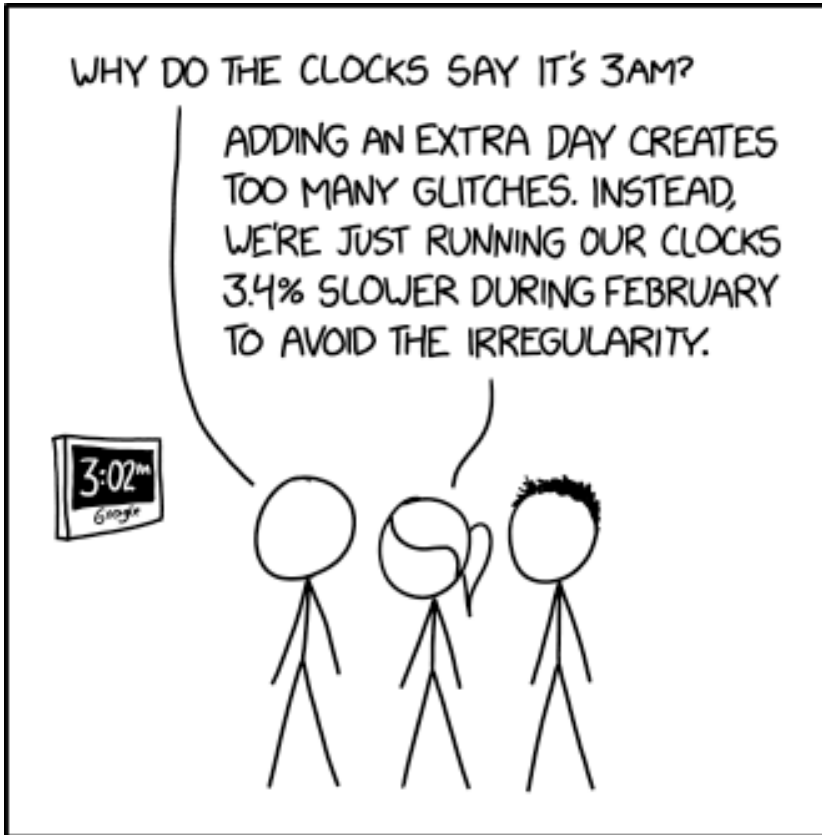
- "claim up to 1040 dependants": typically, taxpayers may claim "dependents" (not "defendants", persons being sued or accused of crimes) to deduct a certain amount of money from their taxable income, which is intended to represent money used for their care. Dependents include children, wards, elderly parents, and others for whom the taxpayer is the primary caregiver, so 1040 would be an absurdly high number. Form 1040 is the number of the primary tax document that must be filed in the United States.
- "seitan local income tax" is a reference to "state and local income tax" which can be deducted from federal income taxes in the US. Most states in the United States have income taxes that must be prepared separately, but some do not. In English, seitan is another name for wheat gluten, used in vegetarian or vegan dishes. This is most likely a byproduct of the AI mishearing "state and" as "seitan".
- "fiscal year 20202": presumably the neural net got carried away with 2's and 0's in 2020. However, at the date the comic was published, Cueball should be filing his 2019 taxes anyway. Alternately, the comic could take place in the future and it took the way most people will speak the year 2022 ("twenty twenty-two") and then transferred this directly to numbers ("20"

"20" "2" becoming 20202).

- "standard deduckling" : the "standard deduction", which is what many taxpayers opt to do rather than attempting to itemize their deductions. The standard deduction is based on filing status and typically increases each year. "Deduckling" is not a word, but "duckling" is: namely, a baby duck.
- "atomizing" his "clams": instead of "itemizing his claims" which, as mentioned above, wouldn't make sense if he was taking the standard deduction anyway. Itemized deductions means to "itemize" or list individual deductions, such as charitable donations, medical expenses, mortgage interest payments, etc. Choosing to itemize deductions may lead to a greater deduction, but requires more effort and supporting documentation, in case of a tax audit. Alternatively, it could be referencing the term "Liquidating finances."

## #2266: Leap Smearing

February 10, 2020



THIS YEAR, GOOGLE HAS EXPANDED  
THEIR LEAP SECOND "SMEARING" TO  
COVER LEAP DAYS AS WELL.

Some people suspect that it started as a "No, I didn't forget Valentine's Day" excuse that got out of hand.

## Explanation

Clocks usually measure time by regularly-sized intervals, but the natural world is not always so accommodating. Since the solar year is not an integer number of days long, we add leap days every four years (except for years divisible by 100 but not 400) to prevent our calendars from drifting with respect to the seasons. We also add leap seconds to the clock every now and then, to prevent noon on our clocks from drifting away from solar noon. Unfortunately, Earth's day is not as regular as Earth's year, so leap seconds cannot be predicted with a formula but are added as needed, most recently in 2016. Officially, the leap second is added at midnight UTC (so a clock will tick 23:59:59...23:59:60...00:00:00), but this is an extremely inconvenient edge case, to the point that there are many proposals to do away with leap seconds entirely (as of this comic strip's publication, the matter will be discussed in the World Radiocommunication Conference in 2023).

Rather than inserting an extra tick into timestamps and dealing with the resulting hiccups (e.g. programs hard-coded to expect that every minute will contain exactly sixty seconds), Google's services 'smear' the leap second over the course of a 24-hour period, officially called Leap Smear by Google. The smear is centered on the leap second (at midnight) so from noon the day before to noon the day after each second is  $11.6\mu\text{s}$  longer ( $1\text{s}/(24*60*60) = 11.574\mu\text{s}$ ). This difference is too small for most of Google's services to be bothered with,

and by centering on midnight, the difference in time will never be more than half a second at midnight; just before midnight it will be half a second behind, after midnight it'll be half a second ahead. This comic's joke arises from the idea of extending this practice to smearing leap days over the month of February. This comic strip was published February 10th, 2020, almost three weeks before the leap day on February 29th, 2020.

In the comic, Cueball is visiting one of Google's facilities, presumably during office hours on the 10th day of February, when the comic was released. But when he looks at their clocks he sees they are all around 3:00 AM (which is in the middle of the night). He thus asks Ponytail and Hairy why their clocks are wrong. Ponytail tells him it is because of leap day smearing.

Ponytail explains that adding an extra day creates too many glitches. So they just run their clocks 3.4% slower during February. She thus states that it works approximately like leap smearing for seconds, so that the extra day's 24 hours are spread evenly over the course of February, keeping it at the regular 28 days, but still running over  $24 \times 29 = 696$  hours, even though their clocks only go through  $672 \text{ hours} = 24 \times 28$ .

Thus the 24 hours less to count are spread out over the 696 real hours, which means their clocks run  $24/696 = 3.445\%$  slower (matching the 3.4% Ponytail mentions). Every smeared day will thus be about 0.86 hours, or 51 minutes and 40 seconds, longer ( $24/28$ ) than a standard day. So when day-smearing clocks read 3:02 AM on

February 10th (the comic was released on February 10th), about 9.1264 smeared days will have passed. This translates to about 9.4523 standard days ( $9.1264 \times 29/28$ ), which is approximately 10:51 AM on February 10th, well within normal working hours.

The joke of course is that contrary to leap second smearing this would be very inconvenient for those following it, due to the fact that clocks would be noticeably out of sync with Earth's rotation (and perhaps more importantly, with everyone else's clocks) for most of the month. (Although it does mean they would sync up better with some of their partners abroad; see 1335: Now and 448: Good Morning.) A different kind of time-smearing was looked at in the far earlier comic 320: 28-Hour Day, which was actually designed with a form of convenience in mind, and it would be interesting to see what the results could be of creatively combining both systems.

The title text humorously suggests that some people (at Google) suspect that the real reason for the leap day smearing was actually a "No, I didn't forget Valentine's Day" excuse that got out of hand. The idea is, that maybe a CEO at Google forgot to buy something for their romantic partner for Valentine, and thus tried to suggest that it was not because they forgot, but that at work it was still February 14th. Presumably, in February 2016, they used this excuse to buy 12 extra hours (as the end of a smeared Feb 14 is exactly halfway through the month) to get their partner a present, and then required the company to actually implement "leap day smearing"

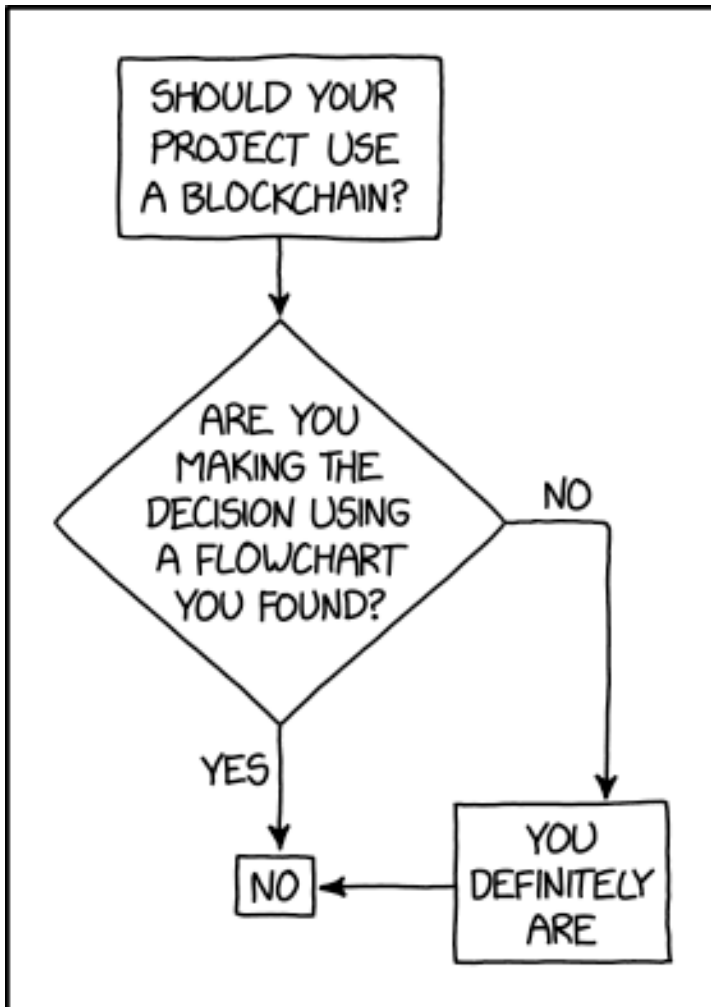
by 2020 to maintain the illusion.

Randall has some issues with Valentines, see for example 1016: Valentine Dilemma. This comic was released four days before Valentines Day of 2020. It was the first time in 8 years he made any reference to Valentine around this time of year, but the seventh time in total. Randall has since not mentioned Valentine's day.

1481: API also covered leap seconds in its title text.

## #2267: Blockchain

February 12, 2020



Blockchains are like grappling hooks, in that it's extremely cool when you encounter a problem for which they're the right solution, but it happens way too rarely in real life.



## Explanation

This comic is a flowchart intended to help project leaders decide if their project needs a blockchain.

A blockchain is a data storage structure shared between various computers. Each block is digitally signed and includes the digital signature of the block before it, which makes it highly resilient against tampering. However, what sets blockchains in the context of cryptocurrencies such as Bitcoin apart from e.g. Merkle trees used in programs such as Git is that anyone can write to a blockchain. This is sometimes specified as a "public" or "permissionless" ledger or blockchain. In order to prevent the blockchain from being vandalized, various mechanisms are used to determine consensus about which additions to the blockchain are legitimate. Bitcoin and most cryptocurrencies use a "proof of work" system, where writing a block includes some task which is computationally difficult to perform but simple to verify, such as finding a magic number (called a "cryptographic nonce") that, when appended to the block, makes its hash value start with lots of zeroes. This results in a system which is, in ideal circumstances, extremely difficult to vandalize, as the attacker must find new nonce values for the block he wishes to modify and every succeeding block, and then broadcast the modified blockchain from enough nodes to convince the rest of the network to go along with it instead of the legitimate one.

In practice, in order to actually make this so-called "51% attack" unfeasible, the network needs to have as many legitimate actors using as much computing power as possible. This results in the Bitcoin network using approximately a million times more energy per transaction than Visa's network, while smaller cryptocurrencies have actually experienced 51% attacks and double-spending. For almost any practical project, there is no need to allow everyone in the world to have write access to a database, so it is generally quite acceptable to use a straightforward centrally-controlled permissioning system rather than proof-of-work or other decentralization schemes to restrict write access. This is why all branches of the flowchart lead to the answer "No".

Part of the joke is that the only question asked in the flowchart, "Are you making the decision using a flowchart you found?" has nothing to do with blockchains or any details of the project itself, and can only honestly be answered 'yes' (which is why the 'no' branch leads to a block reading "You definitely are" before leading to the final "No" answer). For a flowchart with a little more technical content, you can see Figure 6 (page number 42, page 53 of the PDF) of the Blockchain Technology Overview published by NIST. In particular, they conclude that blockchain is only potentially useful if you need a data store that must never be erased (not even for the sake of e.g. removing illegal or harmful content, which has been written into blockchains in the past), must be auditable, and where lots of people need to write

to it (more than can feasibly be enumerated or controlled in any way) but none of them can be trusted to have administrative authority over it.

Presumably, if a project were in the rare category of truly needing a blockchain, that decision would be made by a technical expert who is not consulting this flowchart. This flowchart is probably intended as a "resource" for clueless project managers who have latched on to "blockchain" as a buzzword, such as the investors who tripled the stock price of Long Island Iced Tea after it changed its name to "Long Blockchain Corp." and professed a pivot into the blockchain space. As stated above, one of those real-world problems which is "solved" by blockchains is the libertarian ideal of creating a system which allows anyone to perform transactions while (hopefully) preventing anyone from double-spending their coins, much as physical cash does, but without relying on trusted third parties such as government regulators, banks, or mints. Even in that case, however, cryptocurrency exchanges are running into challenges with anti-money-laundering and know-your-customer regulations, which (among other things) ban certain actors from being served by banks, so they are having to use ordinary certificates, passwords, and identification documents, which are definitely not implemented via a blockchain.

In the title text block chains are compared to grappling hooks. These hooks are devices with several claws (hooks) attached to the end of a rope. A grappling hook is one of Link's weapons from the The Legend of Zelda series.

Additionally, Luke Skywalker used a grappling hook to swing with Princess Leia across a chasm in the first Star Wars film, A New Hope.

Like Blockchains, grappling hooks are thus seen as a cool tool when they encounter a problem for which they are the right solution, like boarding an enemy ship... However, just like for blockchains, in real life there are very few cases where these hooks are the best solution for a given problem. As an example of a problem that is not well-solved by a grappling hook, see 2128: New Robot where an electrically-charged "search and rescue" robot has been equipped with such a hook.

Blockchain was previously mentioned in 2030: Voting Software, with Megan and Cueball expressing distrust in its use for electronic voting.

Flowcharts are a recurring theme in xkcd. If you are unfamiliar with them see 518: Flow Charts. Similar simple flowcharts like this comic, where there is only one reply has been used before like 1723: Meteorite Identification and 2026: Heat Index. See also the similar 1691: Optimization, where the flowchart, as it does here, asks if you are using flowcharts.

## #2268: Further Research is Needed

February 14, 2020

We believe this resolves all remaining questions on this topic. No further research is needed.

### References

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1. [unclear], [unclear], [unclear], [unclear] (2019) [unclear]
2. [unclear], [unclear], [unclear], [unclear] (2019) [unclear]
3. [unclear], [unclear], [unclear], [unclear] (2019) [unclear]
4. [unclear], [unclear], [unclear], [unclear] (2019) [unclear]

JUST ONCE, I WANT TO SEE A RESEARCH PAPER WITH THE GUTS TO END THIS WAY.

Further research is needed to fully understand how we managed to do such a good job.

## Explanation

In most scientific fields, it's very common to end research papers with the caveat that "further research is needed", or words to that effect. This is particularly true when reporting results on a topic that's not well studied, and in which there's not enough literature to form a broad consensus. This is a very reasonable suggestion, an individual research project may produce results that suggest a certain conclusion, but it would be foolhardy to take something as established fact based on a single study. Individual studies may produce misleading information, they may have flaws that don't become evident until later, they may be based on assumptions that don't hold up, or the results may end up having an alternate explanation (as when a correlation is found, but does not establish specific causation). It's all too common for science reporters, particularly in low-quality outlets, to draw broad and bold conclusions from a single study, but actual scientists quickly learn to be more cautious. Peer-reviewed papers will generally make clear that conclusions are tentative, and may be modified or even overturned by future research.

This comic's fictional paper, however, ends with a statement that the paper has resolved all the problems about its topic, and that no more research is necessary. Humorously, the authors are so confident in their research skills that they believe that they have solved all the problems in that particular topic that can be solved. Munroe jokes that he'd like to see researchers with "the

guts" to make such a proclamation. In real life, doing so would likely damage the reputation of the study's authors, because it would reveal both a breathtaking arrogance and a lack of understanding of the research process. If nothing else, studies need to be replicated, to establish that the initial data gathering was accurate. In addition, no single study could realistically address every aspect, variation and complication in a given topic. It's simply not feasible that a single paper could "[resolve] all remaining questions" on any given topic, and making such a ridiculous claim would badly damage a researcher's credibility. At the same time, if no further research were necessary, every researcher in the field, including the author who wrote the study, would need to either change fields or change careers. The title text ironically states that "further research" is indeed needed to understand how the researchers who wrote the paper were able to resolve all the problems in that topic or field, thus allowing the researchers to justify future funding for their research.

Perhaps the statement most like this made by a real scientist was by Albert A. Michelson, at the 1894 dedication of the University of Chicago's Reyer son Physical Laboratory: "[I]t seems probable that most of the grand underlying principles have been firmly established and that further advances are to be sought chiefly in the rigorous application of these principles to all the phenomena which come under our notice." (Variants of this statement are sometimes misattributed to William Thomson, 1st Baron Kelvin.) Even this

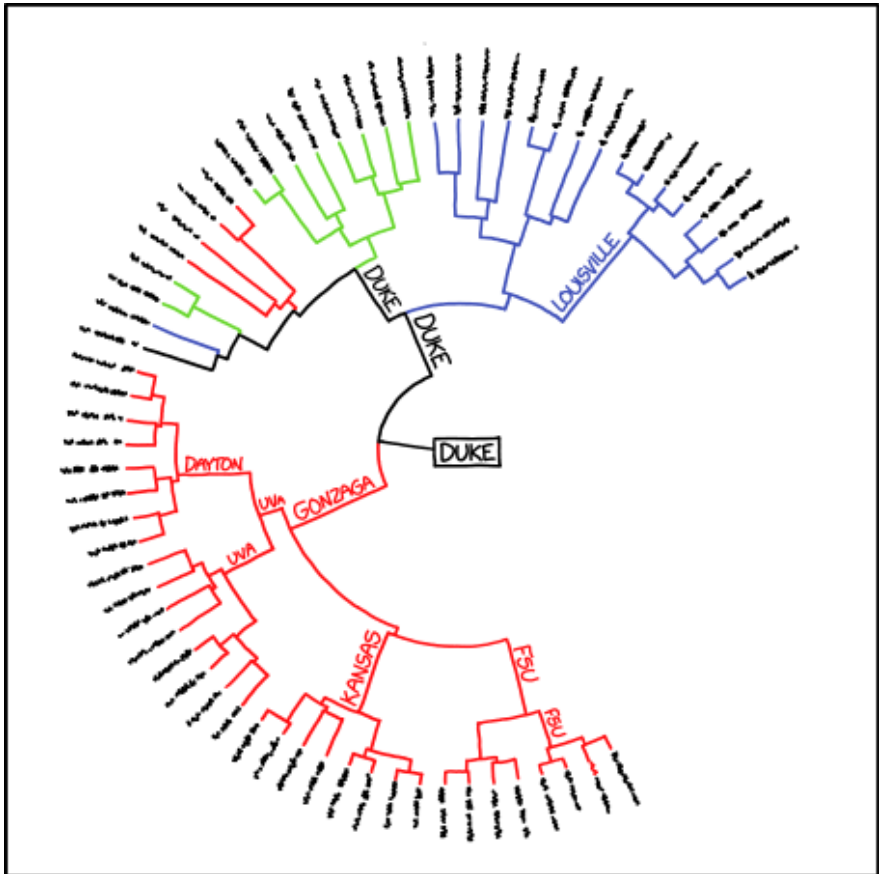
statement is couched in much less certainty than the concluding statement presented in this comic strip, and sure enough, just eleven years later, Albert Einstein wrote his Annus Mirabilis papers. These four papers explained the photoelectric effect, Brownian motion, special relativity, and mass-energy equivalence, turning established physics on its head. Ironically, Michelson made this statement despite the fact that he himself had upset a major notion of established physics just seven years before, when the Michelson-Morley experiment demonstrated that the speed of light was constant, disproving the Aether theories then prevalent in physics. This result in turn was part of the inspiration for Einstein's theory of special relativity.

While not strictly research, mathematical papers often conclusively prove something as a verifiable fact, meaning that "further research" (or study) is often not needed (unless of course the results create more questions to be answered).



## #2269: Phylogenetic Tree

February 17, 2020



I WAS KICKED OFF THE BIOLOGY PROJECT AFTER I  
SECRETLY REPLACED ALL THE PHYLOGENETIC TREES  
IN OUR NEW PAPER WITH MARCH MADNESS BRACKETS.

And I was kicked out of my March Madness pool because I  
wouldn't shut up about the evidence for NBA/ABA  
endosymbiosis.

## Explanation

In biology, phylogenetic trees are a way of showing evolutionary relationships between species. Each split in the tree represents a species that was the common ancestor of the two species beneath it, resulting in a bifurcating structure that can be followed all the way back to a single root - the most recent common ancestor of all species in the tree.

In sport, a tournament tree is a diagrammatic way of showing the progress of competitors in an elimination tournament. Each split in the tree represents the winner of a match between the two competitors beneath it. This too results in a bifurcating tree structure, which eventually terminates at a single root representing the champion of the tournament. Tournament brackets are a recurring theme at xkcd.

In this comic, Randall has taken advantage of the similarity between these two diagrams in order to prank his fellow biologists.

Each year in the United States, in March and early April, 68 National Collegiate Athletic Association (NCAA) Division I college basketball teams play in a single elimination postseason tournament to decide the national champion of college basketball. This tournament is colloquially known as March Madness. Associated with this tournament, it has become commonplace to guess the outcomes of each game, and

predict who will win the tournament. A diagram illustrating the progress and elimination of teams through the tournament is called a bracket. Presumably Randall is referring to the men's college basketball tournament here, though there is a separate women's college basketball tournament that is also referred to as "March Madness".

Randall has replaced the trees in a biology paper with a basketball March Madness bracket, which is not related to biology. The 2019-20 NCAA college basketball regular season had not ended yet at the time of this comic's publication, so the partial bracket shown is a fictional bracket. Compared to a phylogenetic tree, the 'root' of a tournament tree is the final result (once known), rather than the common ancestor that was prior in time to all those that came after; the 'leaves' are all the initially hopeful competitors, rather than the latest extant (or unsucceeded extinct) organisms.

The title text shows the inverse of what the comic says: Apparently the March Madness bracket pool removed Randall after he tried to introduce biology-related evidence comparing the National Basketball Association (NBA) and American Basketball Association (ABA) to organisms and claiming the ABA is an endosymbiont living inside the NBA. An endosymbiont is an organism living inside another organism. In a way, this can be considered true of these two leagues, as the NBA and ABA merged in 1976 after which the ABA ceased to exist. 4 teams from the ABA, the Denver Nuggets, Indiana Pacers, Brooklyn Nets and San Antonio Spurs,

continue to exist today as NBA teams. It is additionally humorous that Randall brings up the ABA/NBA merger in a March Madness bracket group, as March Madness is a college basketball tournament, as opposed to professional basketball played by the NBA and ABA.

A March Madness bracket was also the topic of 1819: Sweet 16.

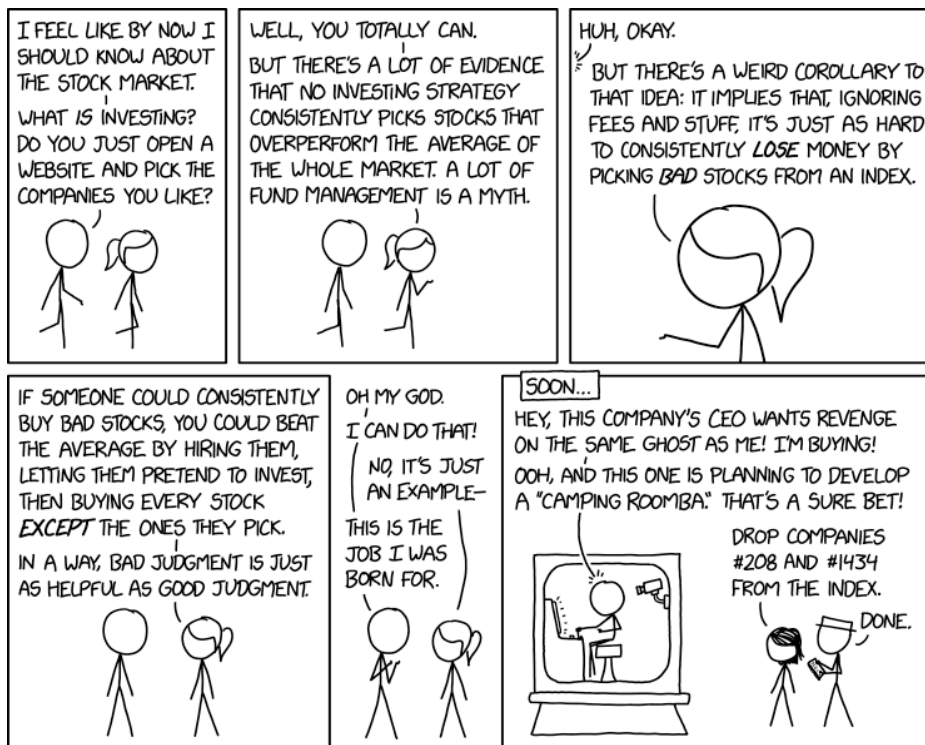
### **Teams shown in the bracket[edit]**

The bracket shows the Duke University basketball team winning the NCAA college basketball tournament. Strangely, it shows Gonzaga University linked only to explicitly non-Gonzaga branches, suddenly appearing out of the bottom section, which is not possible in a sports bracket context, but possible in biology if Gonzaga is an identified ancestral root with all descendant evolved species identified by a new term. In fact, the implied unchanged continuity of Duke from 'universal ancestor' to niche population sharing the world with all of its diverged and re-evolved outbranchings (rather than perhaps used as a term for a typically broad cladistic group of branches, such as Archaea) would be more curious - or just imply an inherent of available precision in the necessary paleobiological studies that classify the proposed UA and its descendency.

As of the publish date of this comic, all of the college basketball teams mentioned (except the University of Virginia) were ranked in the top 25 of the Associated Press poll. The University of Virginia was the 2019 national champion (winner of the tournament), so that may have been why they were mentioned.

## #2270: Picking Bad Stocks

February 19, 2020



On the news a few days later: "Buzz is building around the so-called 'camping Roomba' after a big investment. Preorders have spiked, and..."

## Explanation

In simplest terms, the stock market is a system by which private investors (including individual) can invest in companies by purchasing shares of stock, which can pay dividends, based on the company's net profits, and which rise in value if a company is doing well or is expected to do well in the future. Like many laymen, Cueball apparently understands the concept of the stock market, but is mystified by the complex strategies and vehicles for investment. He asks Ponytail if he can just "open up a website, and a pick a company you like." In fact, in modern times, it's quite easy for individuals to set up online brokerage accounts with relatively small investments, and buy any available stocks they like.

Ponytail then adds that there's a lot of evidence suggesting that no investment strategy consistently outperforms the market. This is significant, because there's an entire industry of "fund management", in which (often highly paid) financial experts determine how clients' money should be invested. The notion is that such managers, being particularly educated and informed on both general economic conditions and the state of specific companies, should be able to select companies that are more likely to do well and avoid those which will do poorly. However, history shows that stock markets in most advance economies tend to rise over time, which means that most stocks are more likely to go up in value, rather than down. Simply choosing more stocks that go up in value than down is relatively trivial,

in order to be valuable, a fund needs to "beat the market", meaning that it appreciates in value more than the entire body of stocks do.

As Ponytail points out, however, there is little evidence that these funds provide much value in the long term. Many studies, such as the long-running "Investment Dartboard Contest" run by The Wall Street Journal, have found that an index of stocks that represent the total market is likely to produce returns just as favorable as an expert. This means a large enough set of randomly-selected stocks (often colloquially stated as "picked by a monkey") is likely to do the same, as it's likely to represent the entire market. The reasons for this are much debated. A lot of the value of stocks is based on perception and speculation about the future, and so exhibits a great deal of unpredictable and quasi-random behavior. And any objective information about a company's health tends to shift the prices very quickly, so the typical investor can't really take advantage of those. While a fund might have periods of significantly market-beating performance, those are generally balanced out by periods of bad luck.

Ponytail then points out an interesting corollary. If movements of the stock market are effectively random, then it's just as hard to consistently lose money by investing as it is to consistently gain money. The reason is that consistently losing money would require a person to be able to consistently identify stocks that are likely to decline in value. The ability to do that would be very valuable, because the more bad stocks you can remove

from your portfolio, the higher percentage of good stocks you'll have left.

Cueball's immediate response is that he's sure can pick money-losing stocks. The final panel suggests that he's teamed up with Megan and White Hat to do exactly that, selecting stocks based on absurd reasons, while the others watch from a distance, and cull his suggested stocks from their portfolio, rather than investing in them.

In real life, this strategy would be unlikely to work, for the exact reasons Ponytail laid out: the trends of individual stocks are too complex and random to predict, so good or bad decision making won't consistently stray from market returns.

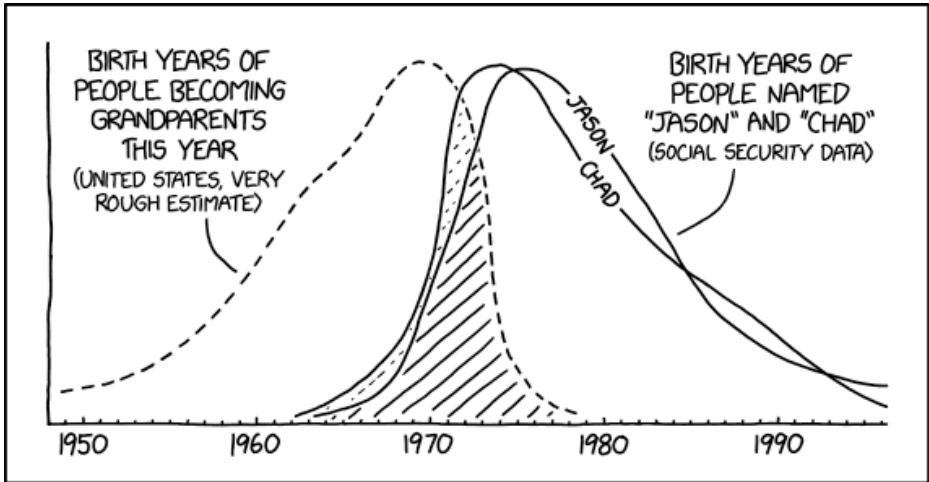
In this example, the disturbing news about these companies (such as their CEO exhibiting erratic behavior, or developing an apparently useless product) is already public, and will presumably have been "priced in" to the market. This means that the stock price will have already dropped as much as it's expected to by most investors. At the same time, individual pieces of bad news don't necessarily mean the company will fail. If the CEO's eccentricities start to impact earnings, they'll probably be replaced. An ill-conceived product may indicate poor management, or it may be a one-off, and other product lines can keep the company profitable. As a result, dropping such companies after bad news, when the stock price is likely to be low, is unlikely to be a winning strategy.



In the title-text, another reason why it's difficult to pick bad stocks is highlighted. Due to a big investment (very possibly, Cueball's investment), the company in question has gotten a lot of attention and a spike in pre-orders. This emphasizes the unpredictability of the markets. People often invest (and even order) based on perception as much as on actual value, and so a company that might seem in trouble might see its fortunes turn around quickly. Because such things are so difficult to predict, beating the market is nearly impossible over time.

## #2271: Grandpa Jason and Grandpa Chad

February 21, 2020



FUN FACT: WE HAVE NOW ENTERED THE ERA OF "GRANDPA JASON" AND "GRANDPA CHAD."

The AARP puts the average age of a first-time grandparent close to 50, and the CDC has some data. But I don't have first-parent age distributions for specific names, or generational first-child age correlations, so the dotted line is just a guess. Still, let's be honest: No further research is really \*needed.\*

## Explanation

This is another comic with one of Randall's fun facts.

The comic contains three separate curves, with the x-axis being the date and the y-axis being the frequency of three separate sets of data:

- The number of people in the US with the name "Jason", a curve that reaches its maximum in 1977, when Jason became the second most common name and reached the maximum number of babies born with that name
- The number of people in the US with the name "Chad," a similar curve that reaches its maximum in 1973, when the number of babies named Chad reached its maximum
- An estimate of the birth years of people that are becoming grandparents, with its maximum in 1968, 52 years ago. The title text explains this is the age at which, on average, most people become grandparents, citing an AARP study

The graph shows that the names "Jason" and "Chad" were extremely uncommon in the US prior to the 1960's, but then experienced a surge in popularity, peaking in the late 1970's, and falling off thereafter. There are a couple of interesting effects when certain names become temporarily trendy. It means that those names become closely associated with a particular age cohort, so one can guess a person's age range based solely on their first name,

and therefore predict other tendencies associated with age (this is also explored in 1950: Chicken Pox and Name Statistics). A side effect of this is that, when this cohort first comes of age, those names enter the public consciousness as being associated with youth, trendiness and irresponsibility. Of course, that cohort continues to age, and eventually becomes the adult cohort, then the senior cohort, but stereotypes are often slow to change. 2165: Millennials is similarly about how a label has outlived the demographic that it was used to describe, while the people described by the label have outgrown the traits that the label entails.

In addition to dealing with the inertia of our assumptions and stereotype, this comic also continues a long XKCD tradition of pointing out how quickly time is passing, and how slow we often are to realize it. In this case, those of us in Randall's general age range are used to thinking of "Jason" and "Chad" as names for young, trendy, party animals. The fact that only a small fraction of people with these names are under the age of 30, and a growing number of them are now grandparents (and that trend is likely to increase rapidly in the next few years), forces us to acknowledge that quite a bit of time has passed since we first formed our world views, and that means we've aged, even if we haven't noticed it.

The title text adds a caveat to the assertion, mentioning the lack of any real evidence for the distribution of ages of Grandparents, but tacitly admits that the matter is not sufficiently important to seek any further precision.

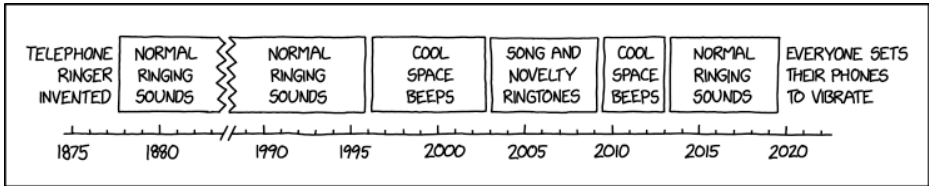
Other possible caveats of the data:

- The Y-axis is in percent of the highest year, not absolute numbers. So while it jokingly implies that, in a few years, all grandparents will be named Jason and Chad, in actuality it will probably be in the order of the hundreds of thousands of people (less than 2% of all grandparents), but still common enough compared to other "ages" to be "the age of Grandpa Jason and Grandpa Chad"
- There are many fewer people whose legal name is Chad than people whose legal name is Jason, so "Grandpa Jason" will probably be much more common than "Grandpa Chad"
- Chad is really more of a nickname, so data on people assigned the name Chad at birth may be meaningless

The title text ends with the text "No further research is really \*needed,\*" referencing 2268: Further Research is Needed. This is also a joke in itself. The emphasis on \*needed\* is an admission that although more research is \*possible\*, it's simply not warranted, given the fairly trivial nature of the topic.

## #2272: Ringtone Timeline

*February 24, 2020*



AFTER 140 YEARS, HUMANITY IS FINALLY ON THE  
VERGE OF WINNING THE WAR AGAINST RINGTONES.

No one likes my novelty ringtone, an audio recording of a phone on vibrate sitting on a hard surface.

## Explanation

After the telephone was invented, a way of indicating when a call was coming through was needed. Special voltages sent through the line were used to activate a physical bell on the other end, leading to what we recognize as a phone ringing sound, and that method of generating sound persisted for quite some time, even when new methods of detecting and generating ringing sounds were developed.

Eventually, however, people realized they were no longer confined to the traditional bell ringing sound, as computers became more and more involved with the telephone process, and variations of bell-type sounds were introduced, often sounding like spaceship sounds from sci-fi movies. Probably the most iconic "cool space beeps" are the chirps from the communicators from Star Trek (which themselves resemble flip-phones in style). Another common ringtone was the Nokia tune.

In the late 1990s and early 2000s, actual songs, or song snippets were able to be used as a ringing sound. It became common to record song snippets from the radio, or to use song MP3 files as ringtones. Many of these songs are grating to hear, and also a social faux pas if they sound in theaters or other listening venues. As an example, this Geico ad featuring bad ringtones, including "the worst ringtone [the Geico gecko has] ever heard", aired in 2010, around the end of the "song and novelty ringtone" period (according to Randall's periodization).

As people got sick of that, they reverted to use the default ring tone, a spaceship / computer sound, although this time often of higher quality and more melodious in nature. Nowadays, there are more people electing to use a more traditional ringing sound, both as the novelty has worn off, and possibly also as an ironic statement about ringtones. Randall (in the person of Cueball) made a statement like this in 479: Tones in 2008, which according to his reckoning was in the waning years of the novelty ringtone epoch.

The final stage the comic is pointing to is do away with traditional sound entirely, and going with the vibrate mode most portable phones have; what little sound there is is more of a low rumbling sound. Using this setting is common for schools, workplaces, or churches, as it can be disruptive to have a phone ring in a public place. Some users have chosen to always set their phones to the vibrate setting, to avoid having to change their ringing settings back and forth. (In most cases, it is also easier to tell whether your phone is vibrating or not than whose phone is ringing.) Randall claims that vibrate mode is the "final victory" over ringtones, which he apparently dislikes.

In the title text, Randall ironically uses a "novelty ringtone" which is an audio recording of a phone vibrating. This would sound like a phone on vibrate mode, but his actual phone is not vibrating, and is actually producing a "ringing" sound. However, if the original phone was vibrating on a hard surface (as opposed to in a pocket, muffled by fabric), the sound

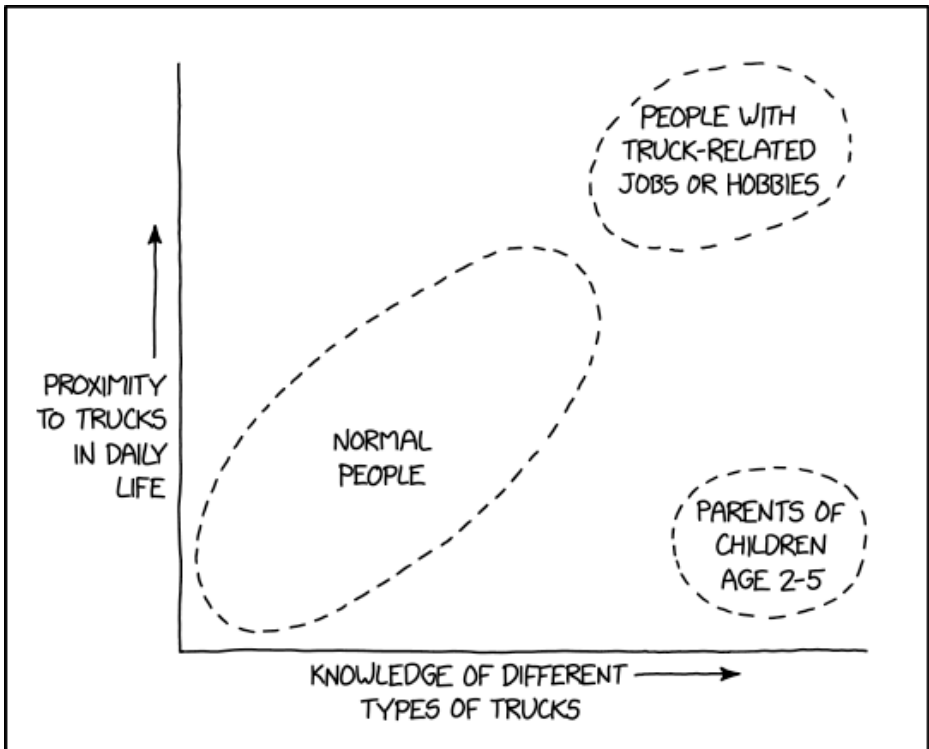


would be much louder and more grating. A recording of that sound, played as an audio ringtone, would go back to being annoying again. But maybe less imaginatively so than might be a version of the staccato "drum-da-da-drum-da-da-drum" of a phone's periodic handshaking with a mast, such as you sometimes hear over unassociated audio equipment, at pretty much any time it pleases.

Another comic about bad ringtones is 1241.

## #2273: Truck Proximity

February 26, 2020



See also: Farm animals and dinosaurs. I am so confident that there exists children's media that involves dinosaurs driving trucks on a farm that I'm writing this without even Googling to check.

## Explanation

This comic is a graph showing the relationship between time spent in proximity to trucks and level of knowledge about different types of trucks. For the general populace the two tend to go together: people who do not spend much time around trucks are less likely to have knowledge about trucks, and people who spend more time around trucks are more likely to have knowledge about trucks. People with jobs or hobbies involving trucks spend a lot of time with them and must know how they work, so they fit this trend but at a higher level on both axes.

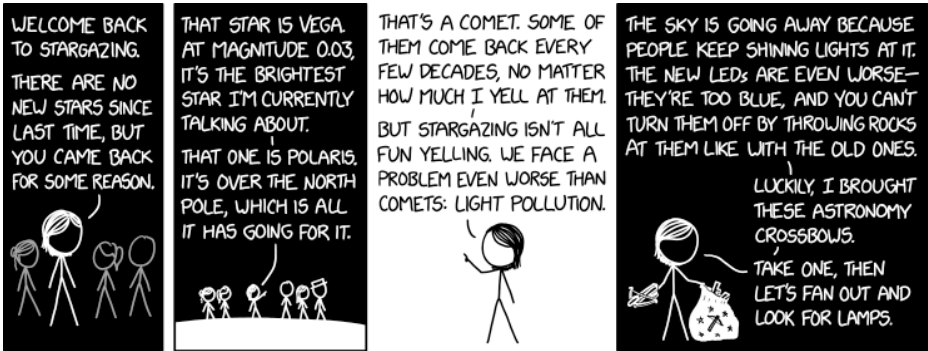
The outlier group presented here are parents of small children. Small children think trucks are cool and learn a lot about them, and then share this knowledge with their parents. The children themselves might be counted into the "people with truck-related hobbies" but parents won't and are unlikely to go near any truck. They might also try to keep their children away from them, which is why they have less proximity to trucks than most normal people.

The title text presumes that this graph could also be made about dinosaurs and farm animals. Randall confidently states that children like dinosaurs and farms and trucks, and so there must be multimedia featuring all three at once. In fact, books about dinosaurs driving tractors on farms do exist (Dinosaur Farm! and Dinosaur Farm are two examples), as are books about them driving

trucks (Dinosaur Rescue!) as well as TV shows about dinosaurs that ARE trucks (Dinotrux). Not all three together so far, apparently trucks and farms do not mix very well.

## #2274: Stargazing 3

February 28, 2020



If we can destroy enough of the lights in our region, we may see more comets, but that's a risk we'll have to take.

## Explanation

This is the third comic in the Stargazing series, and it followed 2017: Stargazing 2 that came out one and a half years prior. It was followed by 3072: Stargazing 4 five years later.

As in the first two comics, Megan is hosting a stargazing event, in which she mixes accurate astronomical information with trivialities, as well as utterly bizarre statements. (See this section from the original Stargazing comic about the host and also the trivia, from the original comic, regarding the gender of the host).

Vega is a star in the constellation of Lyra. It does indeed have magnitude 0.03 and is the brightest star mentioned in this comic. Vega is only the 5th brightest star (outside of the Sun), as Sirius is the brightest visible star. The phrase It's the brightest star I'm currently talking about is an example of the technically correct but not at all useful information that is typical of the Stargazing series. The phrase is true no matter what, because any star one talks about is the brightest star one is talking about, as any brighter star becomes the one talked about when mentioned.[citation needed]

Polaris is indeed the star over the North Pole, and is commonly called the North Star or the Pole Star. It is the brightest star in the constellation Ursa Minor, but there are about fifty other stars that are as bright as it is (magnitude 2), so it's not really remarkable apart from

being the pole star, as Megan says. Despite the fact that being the pole star is "all it has going for it," it is nevertheless very important because it is used for navigation, as it appears fixed in the night sky. It hasn't always been and won't always be the pole star, however, as Earth's axis precesses in a 26,000 year cycle.

Comets are comparatively small clumps of rock and ice, seen mostly by the long, lit 'trail' of particles the heat of the sun causes to be ejected, and the solar wind then spreads outward in thin glowing lines that can be larger and more visible even than the constellations they are seen in front of - at least during the brief phase of their closest approach to the sun. Comets generally have highly elliptical orbits around the Sun and so they are only seen for a brief period of time "every few decades" during their closest approach. Yelling at comets is believed to be an ineffective way to make them go away.[citation needed] Megan may dislike comets because of their history in superstition of being seen as a sign of doom. This provides humor because typically this superstitious fear was caused by a lack of understanding, and it would be expected that a stargazing host would be informed on and therefore unafraid of comets. No actual astronomers are bothered by comets,[citation needed] but some are upset about satellite megaconstellations such as SpaceX's Starlink. In that case, astronomers are not yelling at the satellites, but at the companies that launch them.

Light pollution is indeed a problem with stargazing. Light pollution is the presence of artificial light in the night sky, which makes it very difficult to see stars.

Stargazing in remote locations is remarkably different than in populated cities. Light pollution was previously discussed in 2121: Light Pollution. Light pollution does not actually make the "sky go away", but it does affect how humans can see stars or other astronomical features in the sky.

Megan advocates an active approach to resolving light pollution—rather than lobbying for reductions in artificial lighting, as the dark-sky movement does, she intends to lead her audience in destroying artificial lights.

Older lightbulbs are usually glass bulbs filled with inert gas (for incandescent bulbs) or high-pressure gases (for e.g. sodium-vapor lamps) and so are easy to destroy with any blunt impact, thus accounting for Megan's mention of "throwing rocks at them". Modern LED lights, however, are much more robust, which is why she is handing out crossbows to achieve greater projectile energy. An "astronomy crossbow" is a tool used to measure the angular distance between stars. They cannot shoot real crossbow bolts, but any type of crossbow or other weapon could be used to destroy lights and "preserve" the sky. (Speaking of astronomy tools that have weapon-related names, there is a type of telescope called a "Sun Gun", but it is only meant to be used during the day to enable groups of people to view the Sun safely.

It is probably best that Megan's show is taking place at night, or else she might cause even more trouble.)

In the title text Megan mentions that by destroying enough of the lights in the region will make it possible to see more comets. By reducing the light pollution it will in

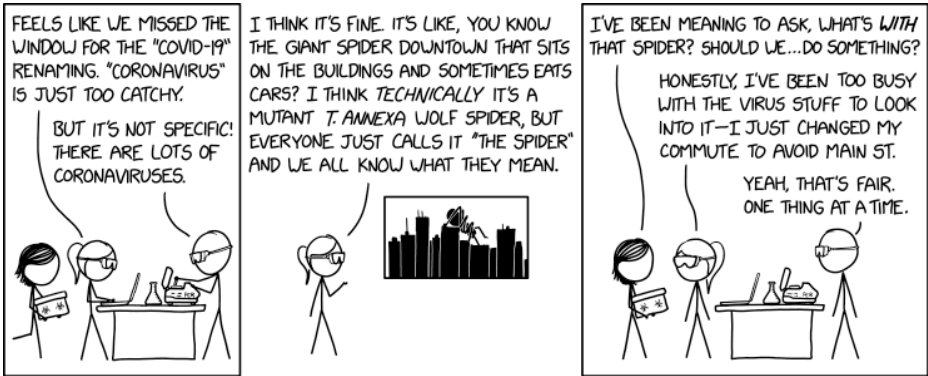


general be possible to see more of any kind of astronomical objects, not just comets. Megan has made clear she dislikes comets, and is thus not interested in seeing any of them. To see more of any of the other astronomical objects out there, she is willing to take the risk of seeing more comets, by lowering the light pollution.

This comic became the last comic not to be related to COVID-19 for more than a month!

## #2275: Coronavirus Name

March 02, 2020



It's important to keep the spider from touching your face.

## Explanation

This comic is the first comic in a long series of comics about the COVID-19 pandemic. For several weeks in a row, all comics were related to this pandemic.

This is thus Randall's first take on the COVID-19 pandemic. As of the publication date (March 2, 2020), the pandemic had infected more than 90,000 people, and had caused more than 3,000 deaths.

Coronavirus is a category of viruses named for their appearance, which is similar to a halo or crown, and includes four different viruses which can cause the common cold in humans. However, the virus itself is not called COVID-19, but is called severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). So calling the virus or disease "coronavirus" is like calling a specific strain of flu The Influenza virus. However, since the new coronavirus is so hyped in the media it has attracted so much attention, so the name "coronavirus" has become associated with COVID-19, making it difficult to discuss other types of coronaviruses later on.

As of March 2, 2020, COVID-19 in China has a 20% hospitalization rate and a 2% death rate by current estimates, compared to a typical rate of around 0.1% for the flu in the US.

In this comic, researchers Ponytail, Megan and Cueball are discussing that it is by now too late to try calling the

disease its official name COVID-19, as the name coronavirus has stuck. Cueball reacts with dismay, since there are many other types of coronaviruses.

To illustrate that Cueball's complaint is excessively pedantic and inconsequential, Ponytail — rather than using a more real-world analogy — compares the coronavirus naming to a giant car-eating spider living on top of the skyscrapers of the town, which people similarly refer to generically as simply "The Spider," even though that is not the most technically-accurate name (it is technically a mutated *Tigrosa annexa* wolf spider). Everyone knows what you mean when you say "Coronavirus", as they do when you mention "The Spider".

The comic then goes on to poke fun at itself by treating Ponytail's example as a real concern, as Megan then asks if they should not also do something about the spider. But Ponytail and Cueball agree that they can only tackle one problem at a time, and coronavirus takes up all their time. Ponytail further notes that she simply began altering her route to circumvent the location where The Spider has taken up residence, as evidence that the Spider issue can be easily avoided, and is therefore not an immediate concern.

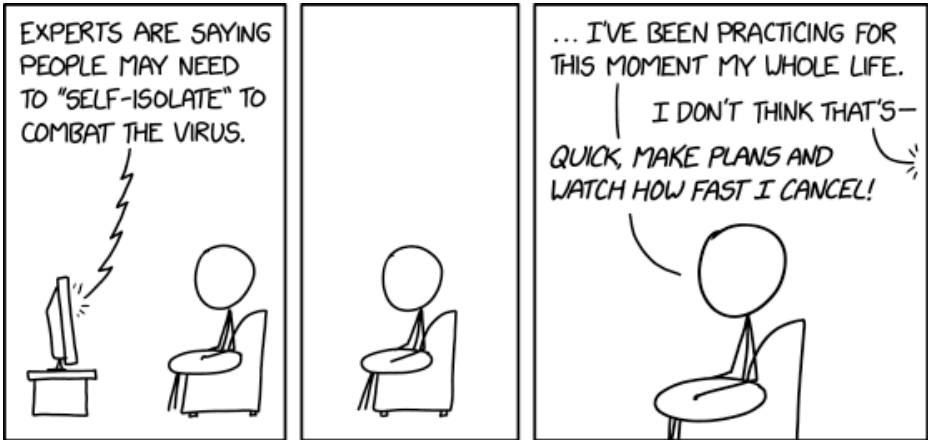
The title text references the health advice that people avoid touching their face with unwashed hands, in order to prevent infections that they picked up by touching things from entering their mucous membranes. (It's a lot easier for an infection to enter the body through the

inside of your nose than your hands.) It is likewise quite important to keep the giant spider from touching your face, but for the dissimilar reason that it might bite and eat you.

Notably, the rename to COVID-19 did eventually catch on as the default description of the disease caused by "The Coronavirus" SARS-CoV2.

## #2276: Self-Isolate

March 04, 2020



Turns out I've been "practicing social distancing" for years without even realizing it was a thing!

## Explanation

This comic is the second comic in a row in a series of comics about the COVID-19 pandemic.

In this comic, Cueball is watching television and hears a suggestion that people may need to "self-isolate." This refers to the practice of isolating infected individuals, to keep the disease from spreading. If the pandemic grows more severe, going out in large crowds could also be discouraged, to avoid being infected by those around you.

According to the HHS, both quarantine and isolation help prevent the spread of infectious diseases, but they are different. Quarantine is for well people who might have been exposed to see if they become sick. Isolation is for sick people to keep them from infecting healthy people. So the suggestion for self-isolation means that sick people should stay away from healthy people.

Cueball's response to this advice is that he's "been practicing for this moment [his] whole life". xkcd frequently refers to social awkwardness, introversion, and difficulty with interpersonal interactions. Cueball (likely representing Randall himself) appears to find spending time in public and with large groups trying. It's implied that he prefers to spend time alone (or possibly with small groups of family and close friends) rather than going out. The joke is that this tendency is often seen as unhealthy and alienating, but in the case of a pandemic,

actually becomes quite valuable. Cueball seems to take an odd sort of pride in the fact that he's skilled at remaining alone and uninfected, while more social people would be in danger.

The comic image is a link to one tweet in a thread of tweets about COVID-19 by @kakape, a science journalist according to their Twitter bio, which says "Social distancing may mean staying further apart from each other physically in coming weeks. We should compensate by caring even more about each other than usually, because we are, of course, all in this together." (beginning of thread).

In the title text, Cueball continues to be proud of his introversion, claiming that he has been "practicing social distancing" for much of his life.



## #2277: Business Greetings

March 06, 2020



We have email and social media now, so we probably don't need to keep exchanging business cards by pressing them gently against each others' faces with an open palm and smearing them around.

## Explanation

This comic is the third comic in a row in a series of comics about the COVID-19 pandemic. With this comic also on that topic, all comics of that week were about the pandemic. This continued for many more weeks.

As a reaction to the COVID-19 pandemic, people are refraining from personal contact. This leads to changes with customs in the workplace, such as shaking hands at the beginning of a meeting.

The comic shows Beret Guy addressing his employees at his eccentric company (Ponytail, Hairy and Hairbun, see also 1997: Business Update). He states that although they should not overreact to the coronavirus, they should at least stop their custom of beginning meetings by "licking each others' eyeballs". Virus or not, it is not common for people to lick anyone's eyeballs at meetings,[citation needed] but it could be an extreme stretch of intimate behavior to make an analogy to some cultures' norm of kissing acquaintances in greeting.

Humorously, his employees state that they will miss this human contact, but that they at least understand.

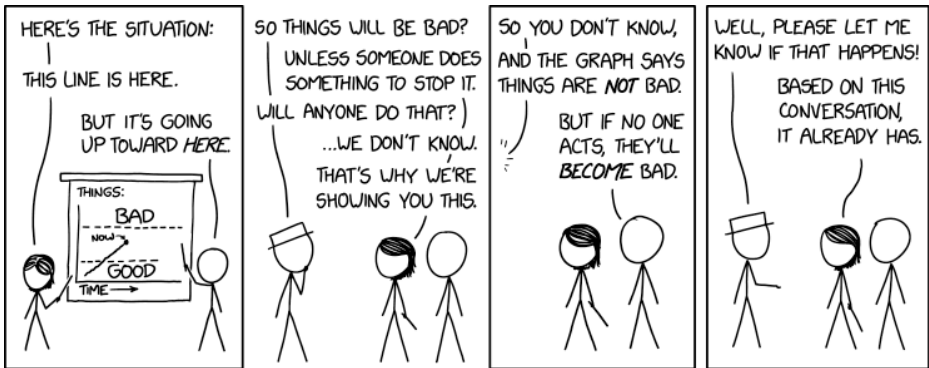
Contact between saliva and eyes are a very common way to spread the disease. However, this usually occurs from one infected person sneezing and airborne particles randomly coming in contact with an uninfected bystander's eye, or people touching their own faces and

eyes after having touched an infected surface, not by applying the saliva directly to a person's eyeball by means of another person's tongue. Also, most people's eyelids instinctually close when they see an object, including someone else's tongue, about to hit them in order to protect the eyeballs, so actually licking each others' eyeballs, as opposed to merely each others' eyelids, would be very difficult for most people, but Beret Guy being able to do this would not be very surprising considering his other abilities, such as being immune to his head being impaled.

The title text refers to an actual business custom (exchanging business cards), but one which is absurdly altered to promote the spread of disease by touching cards and hands to faces. It is not clear whether this is safer or more dangerous than Beret Guy's previous practice of eating business cards, see 1032: Networking.

## #2278: Scientific Briefing

March 09, 2020



"I actually came in in the middle so I don't know which topic we're briefing on; the same slides work for like half of them."

## Explanation

Things are not good, and are going to be bad soon. The only way for things to not be bad is for someone to do something about it. Megan and Cueball are presenting these things to White Hat, evidently hoping to encourage him to do something about things, but he instead chooses to wait for things to become bad, to which Megan replies that the conversation itself indicates they have become bad.

Megan's final remark — "Based on this conversation, it already has [become bad]" — is an instance of recursion, and suggests that the unnamed subject of the graph may be something whose worsening is demonstrated by the way the discussion of the graph has gone. The subject of the graph could, therefore, be the phenomenon of people not acting on things that are worsening until they actually become bad, as White Hat proposes to do. Alternatively, if the group of people who could stop the Bad Thing is either small, or made up of people who will predictably act like White Hat, the fact that White Hat has refused to act itself means that will become bad, which is bad.

At the time this comic came out, the outbreak of COVID-19 was on the rise and about to be declared a pandemic, with widespread perception the US federal government had failed to act before the outbreak became a crisis. The first of the COVID-19 comics, 2275: Coronavirus Name, explicitly showed people not dealing

with one problem while they concentrate on another (though in that case they were dealing with COVID-19 while neglecting an invading giant spider).

The recursive subject of the graph could also be the deterioration of data analysis into such abstract terms that it no longer depends on the content of the topic supposedly being analyzed. Or, Megan's final remark could be an ironic commentary on the situation without actually referring to the topic of the graph. The ambiguity of Megan's remark may be the point of the humor, as it compounds the absurd ambiguity of the entire discussion.

If the graph isn't about the recursive topic of the discussion, what might it be about? At the moment of release, an obvious possible thing on its way to becoming bad was the number of cases of infection in the COVID-19 pandemic. There were a series of comics about COVID-19, including the three comics immediately before and the four immediately after this one. The graph shows a steadily rising line, but with a slight zigzag in it, which could be an intentional similarity to the Keeling Curve.

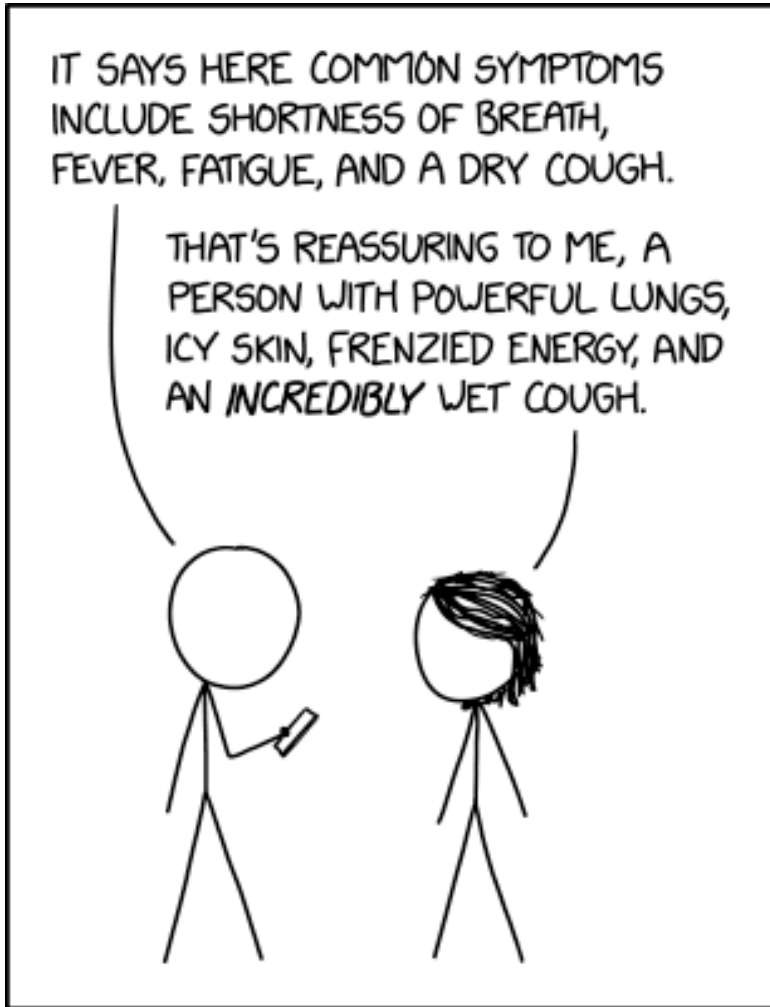
The graph could also be about most anything else, because, as the title text remarks, it applies to "like half of" any things considered. While it's hard to say whether precisely 50% of all things are getting bad (or good), in a more general sense all line graphs would trend at least slightly either up or down. This binary 'either good or bad' finding may lead one to conclude that "like half" of

all graphs show something getting bad (or else good). If not everyone agrees on what is "good" or "bad" on some issue, that same issue might even be viewed as going either from good to bad or from bad to good, providing two different graphs for each such issue with 50% of them broadly matching the comic.

To whatever extent this comic is related to COVID-19 — which it does not after all explicitly mention, but, at least, COVID-19 exemplifies the problem of waiting to act until things reach a crisis — it would be the fourth comic in a row in a series of comics related to the COVID-19 pandemic.

## #2279: Symptoms

March 11, 2020



This medicine says it may cause lightheadedness, dry mouth, and blurred vision, but my head feels incredibly heavy, water is pouring from my mouth, and I can see individual hummingbird wingbeats, so I think I'm fine.



## Explanation

This comic is the fifth comic in a row in a series of comics about the COVID-19 pandemic.

The comic states that the symptoms of a disease are shortness of breath, fever, fatigue and dry cough. These are the top 3 and 5th most common symptoms reported for COVID-19. This is thus the fifth comic in a row about this disease, released on the day that the World Health Organization declared the COVID-19 outbreak a pandemic.

Looking these symptoms up on his phone, Cueball reads them to Megan who expresses relief. The experiences of hers she claims as normal are so extremely opposite to the symptoms of the disease, that getting it might even be a boon rather than a harm. If a person has powerful lungs, shortness of breath wouldn't be very noticeable. She references icy skin, normally not a fever symptom, although heavy sweating caused by fever can lower temperature. She describes having frenzied energy, the opposite of fatigue.

The last symptom is an "incredibly wet cough", and although that is the opposite of a dry cough, it still sounds quite bad. The description she gives opposes COVID-19, but may be indicative of something else.

The focus on how symptoms play out differently for people with different normal experiences distantly

touches on, but deftly evades, the harsh reality that people who, unlike the comic's characters, already have severe respiratory issues, may die in large quantities unless our response to the virus improves. This is because the impact of a disease relates to how bad its symptoms are for the carriers.

Megan's optimistic reaction is ironic, considering these could be symptoms of a whole host of medical situations, including any kind of flu.

The title text expands on this joke. Cueball reads up on the side effects from some medicine. Here again they don't have the common side effects of the medicine but the exact opposite, so they think they must be fine, even though those "anti-symptoms" are themselves cause for concern.

It also reflects on the whole concept of symptom/side effect warnings themselves as often people have no good frame of reference for when a particular symptom is actually abnormal. It is often easy for one to believe they match some or all of a list of symptoms because for someone to be absolutely sure they do not have a specific symptom, they would need an almost comic level of "normality".

The medicine is supposed to make the user:

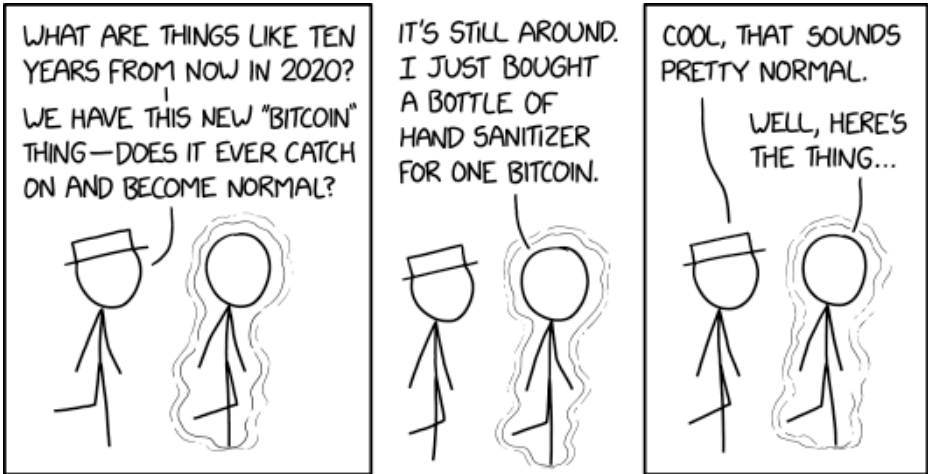
Having a heavy head is not a good sign, even though the opposite is also not good. Dry mouth can be annoying but her condition sounds dangerous. And although

blurred vision is a bad thing, it is impossible for a human eye to follow the 12-80 beats a second of a hummingbird; this suggests that Megan might be hallucinating, which is arguably even worse.

Much later in 2580: Rest and Fluids, the joke is again on symptoms or rather getting them again. The pandemic was still going almost two years later.

## #2280: 2010 and 2020

March 13, 2020



2030: "I just bought a house for one bitcoin. No, it's the equivalent of a dollar. Houses are often transferred for a nominal fee because the buyer is taking responsibility for containing the holo-banshees in the attic."

## Explanation

This comic is the sixth comic in a row in a series of comics about the COVID-19 pandemic.

White Hat, who lives in 2010, and Cueball, who lives in 2020, are in contact with each other via some kind of time travel. White Hat wants to learn about life in 2020 and is particularly interested in bitcoin, a decentralized cryptocurrency which was released in 2009, and whether it had become an acceptable currency. Cueball answers that bitcoin still exists, and that he just bought a bottle of hand sanitizer for the price of one bitcoin. White Hat probably assumes that bitcoin is a widely accepted currency worth a few dollars, and thinks that the situation is "normal". (In April 2010, one bitcoin was worth about 14 cents.)

At the time of this comic, COVID-19 is spreading around the world, causing thousands of people to die (although relatively few compared to the number of people that have gotten better) and billions to panic. This increased the demand for hygiene products, including hand sanitizers, and therefore their price has increased. It also triggered a panic on financial markets, including severe devaluation of the infamously volatile bitcoin. Despite the crash, one bitcoin was still worth about \$5,400 on the day this strip was published, not a few dollars. Therefore, buying a hand sanitizer for one bitcoin is not as normal as White Hat assumes.

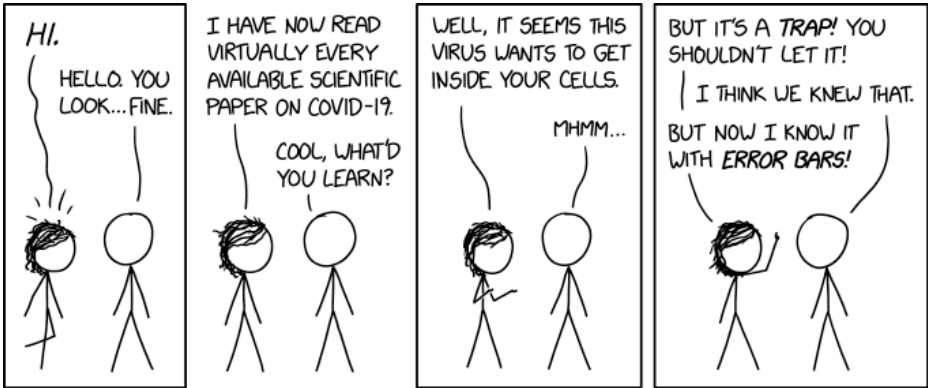
The price of hand sanitizer has not reached the price of a bitcoin (yet), although some people on sites such as Amazon.com are attempting to sell it for ludicrous amounts and there are attempts by Amazon, eBay, and other selling platforms, as well as potential legislation, aimed at curtailing such price gouging.

The title text claims that, in 2030, bitcoin will again be worth about one dollar, but many houses will also be worth only one dollar due to the difficulty inherent in containing "holo-banshees" in the attic. What a holo-banshee is is not explained, but one can guess as to what it might mean. "Holo" is generally short for hologram and typically denotes some kind of 3D looking digital visual form, and a "banshee" is a mythological wailing creature or spirit. So even if not a physical object, constant shrieking would be undesirable.[citation needed]

The "nominal fee" mentioned by the 2030 time traveler is known in legal parlance as a "peppercorn". In reality, such a practice has been quite common for several decades (though not for something on the scale of a house); legal processes state that both sides must give something in order for a contract to exist, and a minimal peppercorn payment to secure a contract is preferable to the legal hoops that must be jumped through in order to lawfully give something away for nothing.

## #2281: Coronavirus Research

March 16, 2020



"Also, reading 500 coronavirus papers in a row and not sleeping? Probably not great for you either, but I haven't found any studies confirming that yet. I'll keep looking."

## Explanation

This comic is the seventh comic in a row in a series of comics about the COVID-19 pandemic.

Megan, disheveled and exhausted, has been researching COVID-19 nonstop and is now reporting her findings to Cueball. She claims to have read all available literature on the subject, but the best she can come up with is an extremely basic fact about viruses—namely that they infect cells and this is bad and should be prevented, which Cueball and just about everybody else already knew. She enthusiastically replies that she now knows this with error bars, which are graphical representations of the variability of data and are used on graphs to indicate the error or uncertainty in a reported measurement. Perhaps because of her sleep deprivation, she is unable to process the information that she has read, or is unable to properly phrase it in words. This is not the first time that Megan has exhaustively researched a topic to the detriment of her own health, see 1708: Dehydration.

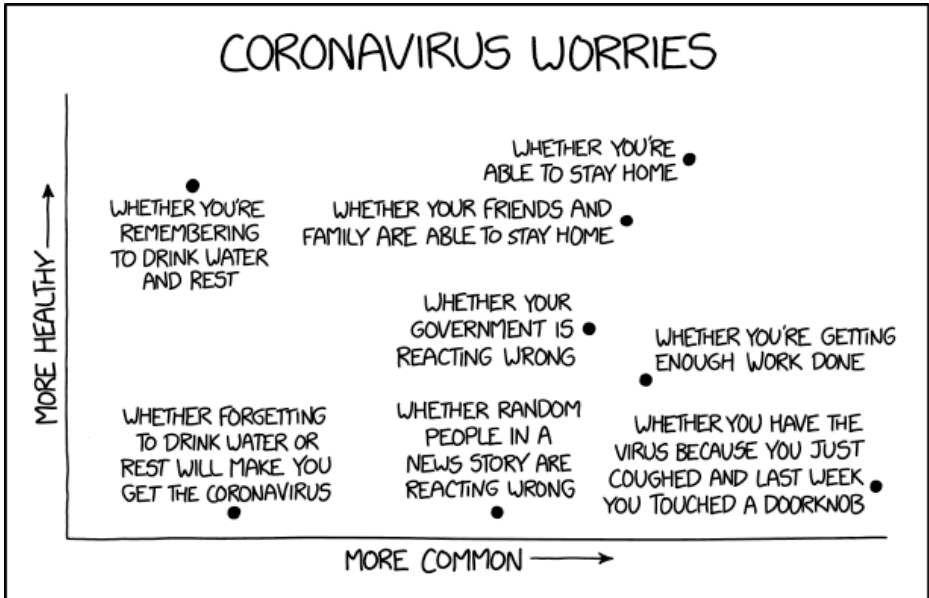
In the title text, she has a hunch that staying awake long enough to read 500 scientific papers is probably not a good idea, but she hasn't found a study that specifically confirms that. She intends to further compound her exhaustion by continuing to do research rather than just getting some much-needed sleep. Assuming that Megan averages half an hour to find and read each paper, she has been continuously reading for 10.4 days, which is



approaching Randy Gardner's world record for not sleeping (11 days and 25 minutes).

## #2282: Coronavirus Worries

March 18, 2020



Offscreen, bottom left: Whether the custom :coronavirus: Slack react emoji you just added was public domain or whether you should have put a Creative Commons credit somewhere

## Explanation

This comic is the eighth comic in a row in a series of comics about the COVID-19 pandemic.

Randall has created a scatter plot graph showing "more common" worries versus the "more healthy" worries. Presumably, "more healthy" refers to more important things to worry about concerning the COVID-19 pandemic. From this graph, Randall notes that the "more healthy" concerns are not necessarily the ones that are the most common.

On the left side of the graph, signifying "less common" worries/concerns are concerns relating to the drinking of water, and resting. Drinking water (staying hydrated) and getting enough sleep each night are important ways to fight off disease, and they're things that almost everyone can take direct action on, so this is marked as one of the most healthy things to worry about. In 2281: Coronavirus Research, Megan shows signs that she (like many) has not been taking care to get enough sleep. However, not drinking enough water and not sleeping enough are not likely to cause coronavirus specifically, so that particular worry is marked as one of the least healthy.

In the middle of the graph are "medium common" worries/concerns. The "most healthy" or vital concerns are being able to stay home and the ability for friends and family to stay home. Across much of the world, public

gatherings have been discouraged, including requiring many workers to telecommute. This is following the principle of social distancing, to slow the spread of COVID-19. These are considered very healthy concerns to be having.

Below these two concerns is concern about the government response, specifically if the government is "reacting wrong". Many world governments have been criticized for inadequate responses to the pandemic. However, even if the government's response (or lack of response) is incorrect, it is not something that most people can control directly, nor should it prevent people from taking care of the more healthy concerns about staying home and staying well-hydrated and well-rested, which is why this worry is marked as being only moderately healthy. Even less important than the government response is worrying about the reactions of random people featured in news stories (who are most likely featured specifically because their behavior is extreme or aberrant) or Internet trolls or people who have different opinions to you in the story's comments section.

A more common concern listed is "whether you are getting enough work done". Telecommuting (working from home) may be less productive than working at the normal office, so Randall or others may be concerned about their work productivity. For people working in industries that directly affect the health and well-being of others, such as medicine, this is a fair concern (and many of the event cancellations and other responses are

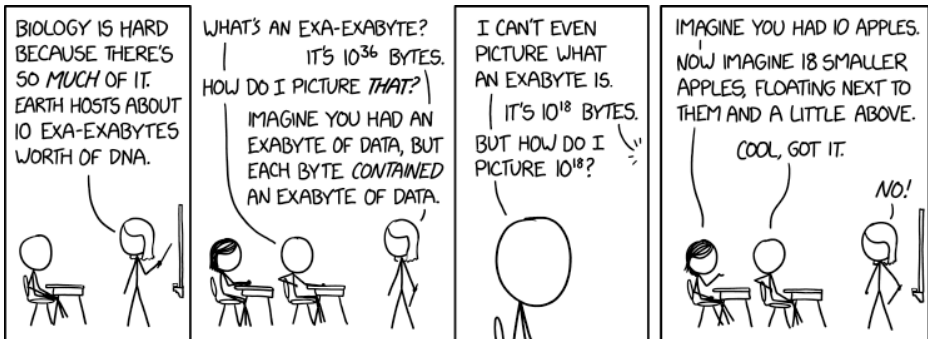
intended to make their jobs easier), but in general, this is a much less healthy concern than staying home and well-rested.

The most common and least important concern according to Randall is "whether you have the virus because you just coughed and last week you touched a doorknob". Though it is an important to be concerned about catching the coronavirus, simply coughing a few times or "touching a doorknob" are unlikely reasons to suspect having COVID-19. Most cases of COVID-19 do include a cough, and the disease can be latent for over a week before showing symptoms, but also include other symptoms, including fever and difficulty breathing.

The title text lists an uncommon, unimportant concern: the copyright status of a "coronavirus emoji" on Slack (a business instant messaging software). The Creative Commons license is a license allowing for fair use of published work (and presumably emojis) that are otherwise copyrighted. Something that is in public domain has no copyright protection on it, and can be used freely. Presumably, this is a concern that only Randall has, making it uncommon. It is also relatively unimportant in the greater scheme of the COVID-19 pandemic.

## #2283: Exa-Exabyte

March 20, 2020



To picture  $10^{18}$ , just picture  $10^{13}$ , but then imagine you connect the left side of the 3 to close off the little bays.

## Explanation

This comic is arguably the ninth comic in a series of comics related to the COVID-19 pandemic. This comic does not mention the disease but it does mention biology.

This is a comic about the difficulty of picturing or understanding large numbers. As mentioned in the comic, an exabyte is  $10^{18}$  bytes, while an "exa-exabyte"—not a common word, but one that abuses the principles of metric prefixes—would be  $10^{36}$  bytes.  $10^{36}$  is properly given the name undecillion (in short scale, and sextillion in long scale).

According to a 2015 article by The New York Times, researchers estimate that there are about  $5 \times 10^{37}$  DNA base pairs on Earth (50 trillion trillion trillion). So Miss Lenhart's claim of 10 exa-exabytes— $1 \times 10^{37}$  bytes is a reasonable approximation (Fermi estimation). (The estimate was  $5 \pm 4 \times 10^{37}$ . There are 4 possible base pairs, or 2 bits per pair, a byte is 8 bits.)

These numbers are larger than most people can imagine. Even much smaller numbers such as a billion ( $10^9$ ) or a trillion ( $10^{12}$ ) are hard to imagine. For instance:

- 1 billion seconds is equal to 31.7 years; 1 trillion seconds is equal to 31,688.74 years.
- 1 billion grains of rice weigh approximately 34,447 lb (15,625 kg).

Wikipedia has an article on the exabyte and one on large numbers which describes various things close to  $10^{18}$ .

- TOI 700 d, a potentially habitable Earth-like exoplanet is 100 light years away, which is about  $10^{18}$  meters.

Cueball expresses his difficulty in visualizing a number even as large as one exabyte ( $10^{18}$  bytes).

Megan trivializes the problem away by describing an exabyte as 10 apples, with "18 smaller apples, floating next to them and a little above", representing the notation  $10^{18}$  using apples for digits. This is entirely unhelpful, as using apples in a base-1 enumeration offers no obvious advantages over base-10 in understanding exponents; Megan's bad advice and Cueball's seemingly ready acceptance of it causes Miss Lenhart to yell out "No!" in frustration.

The title text further trivializes the problem of visualizing large numbers by suggesting that you can visualize  $10^{18}$  as a number by simply visualizing the similar-looking number of  $10^{13}$  with some extra lines drawn to turn the 3 into an 8. Changes in exponents can cause huge changes in the value shown, and this is no exception: Changing that 3 into an 8 changes the value by a factor of 100,000.

Randall has previously discussed the difficulty of large numbers in 2091: Million, Billion, Trillion, 1894: Real Estate, and 558: 1000 Times.

1605: DNA also discusses how "hard" biology is.



## #2284: Sabotage

March 23, 2020



IN THE CORONAVIRUS ERA, DESPERATE  
TIMES CALL FOR DESPERATE MEASURES.

So excited to see everyone after my luxury cruise home  
from the World Handshake Championships!

## Explanation

This comic is the tenth comic in a row in a series of comics about the COVID-19 pandemic.

In the wake of the COVID-19, the advice from many professionals in the United States is to avoid public gatherings to slow the spread of the disease and "flatten the curve".

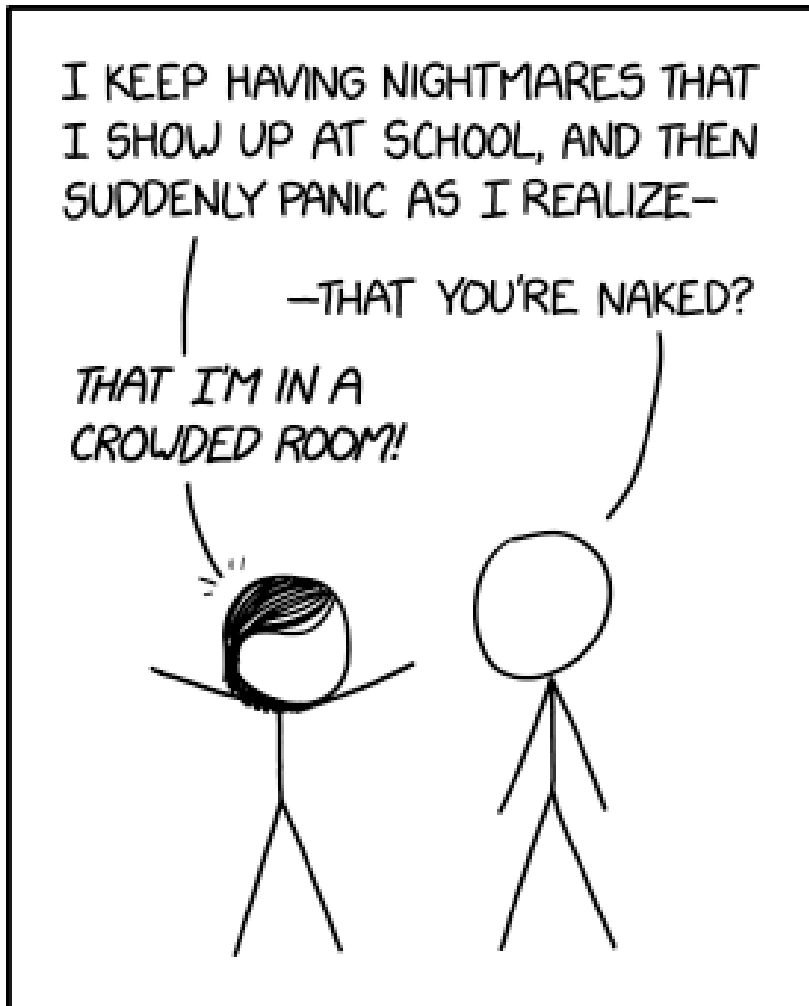
In this comic, some group of people (we're not told who) are planning a public event, which is very much contrary to the widespread professional advice, and is said to put everyone at risk by accelerating the spread of the disease in the general population. In an effort to sabotage this event by deterring people from attending, Cueball applies reverse psychology, pretending to be enthusiastically planning various activities at the gathering that most people would go out of their way to avoid: a wild skunk petting zoo, which would most likely result in everyone getting heavily sprayed with violently foul-smelling skunk scent that wild skunks use to drive away predators; and karaoke featuring the song "Baby Shark", which is a song for small children that is generally considered annoying to adults, made even more direly annoying in this case by being spoken rather than sung.

In the title text, Cueball has stepped up his game from merely threatening to spoil everyone's fun to making them fear that they might get infected. He claims to have

attended the "World Handshake Championships", which presumably would involve shaking hands with as many people as possible; this would facilitate the spread of diseases such as COVID-19. He furthermore claims to have traveled home from the championship via a cruise ship, which may also cause concern because cruise ships are known for their densely populated environments and lack of extensive medical facilities making prevention and treatment of infections very difficult or impossible. Cruise ships have been a recent topic of interest in relation to SARS CoV-2 due to many people being stranded at sea with infected patients because of COVID-19 pandemic on board.

## #2285: Recurring Nightmare

March 25, 2020



Oh thank goodness, I forgot my clothes, so now everyone's looking embarrassed and backing away.

## Explanation

This comic is the eleventh comic in a row in a series of comics about the COVID-19 pandemic.

Megan states to Cueball that she keeps having the same nightmare. As she begins to explain that in her dream she shows up at school and panics as she realizes something, Cueball interrupts her to suggest she has turned up at school naked. But instead, Megan says that she finds herself in a crowded room at school.

It is an allegedly frequent dream-trope to be in a situation of otherwise polite company and discover oneself naked in the midst of the crowd. This can be added to something such as a general "forgotten to prepare for the exam you're sitting" to build upon various levels of worst-case scenario anxieties amongst your peers, parents or other persons who will judge you badly for your faux pas.

In light of the current COVID-19 pandemic, Megan is obviously dreaming up her problem of being in a crowd (at school), as most schools have stopped holding in-person classes (at the time of this comic, most schools in many countries had switched to online instruction or have completely closed due to the pandemic).

Social distancing has been widely practiced around the world as a way to slow the spread of the disease. In the title text, Megan finds relief in dreaming that she's naked,

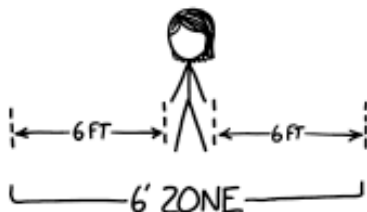
as her nudity, perhaps similar to the actual real-life 'health tip' of eating excessive garlic, has the unintentional but beneficial effect of having crowd members back away from her personal space out of shock and/or mutual embarrassment. This may somewhat mitigate the viral transmission by droplets from coughs, although to be more protected, Megan should dream that she is at least wearing a face mask, or that she is going to thoroughly wash her hands as soon as possible, in case she has touched any contaminated surfaces.

Nightmares about school were also the topic of 557: Students, specifically stating that people have dreams about school, even when already having graduated.

## #2286: 6-Foot Zone

March 27, 2020

### GUIDE TO THE 6' SOCIAL DISTANCING ZONE



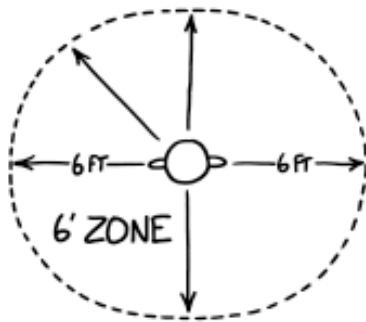
APPROX. AREA: 145  $\text{ft}^2$

BORDER LENGTH: 43 FT

POPULATION DENSITY: 190,000 PEOPLE/MILE<sup>2</sup>

VALUE AT NYC REAL ESTATE PRICE/FT<sup>2</sup>: \$195,000

MAXIMUM NUMBER OF  
HORSES THAT COULD  
FIT INSIDE IT WITH YOU,  
ESTIMATED USING THE  
DIMENSIONS IN THE  
US FOREST SERVICE  
EQUESTRIAN DESIGN  
HANDBOOK: 8



Technically now it's a 34-foot zone.

## Explanation

This comic is the 12th comic in a row in a series of comics about the COVID-19 pandemic.

This comic is about social distancing, a common practice to prevent the spread of the COVID-19. It has been suggested to maintain 6 feet (i.e. 1.8288 m - in e.g. France and Britain the suggested distance is 2 m) of distance between yourself and other people, to prevent the transmission of respiratory droplets from you to others (or vice versa).

Randall takes this 6 feet of distance, and does calculations of the "area" of distancing, "border", population density, and "real estate value". He finally culminates in determining the number of horses that could also fit in the space.

Randall's border length and approximate area calculations are based on a zone with an outside radius of approximately 6.8 feet or 82 inches (2.07 m), meaning that the person has a radius of approximately 0.8 feet (9.6 in, 0.24 m). That is,  $2\pi(6.8\text{ft}) = 42.7\text{ ft}$  and  $\pi(6.8\text{ft})^2 = 145.3\text{ ft}^2$ .

There are two different population densities that can be calculated. The one used by Randall in the comic is the population density of the exclusion zone itself, i.e. just the reciprocal of its area. This is  $\pi^{-1}(6.8\text{ ft})^2 = 190,000\text{ mi}^{-2}$ . A different density is the density of a crowd in



which everyone obeys the distancing rules. That would result in  $0.9069(\pi-1)(3.8\text{ft})^{-2} = 560,000 \text{ mi}^{-2}$  population density. When people stand 6ft apart from each other, their exclusion zones are overlapping; instead we can use smaller circles with 3.8 ft radius that are not overlapping. 0.9069 is the packing density of circles in the plane.

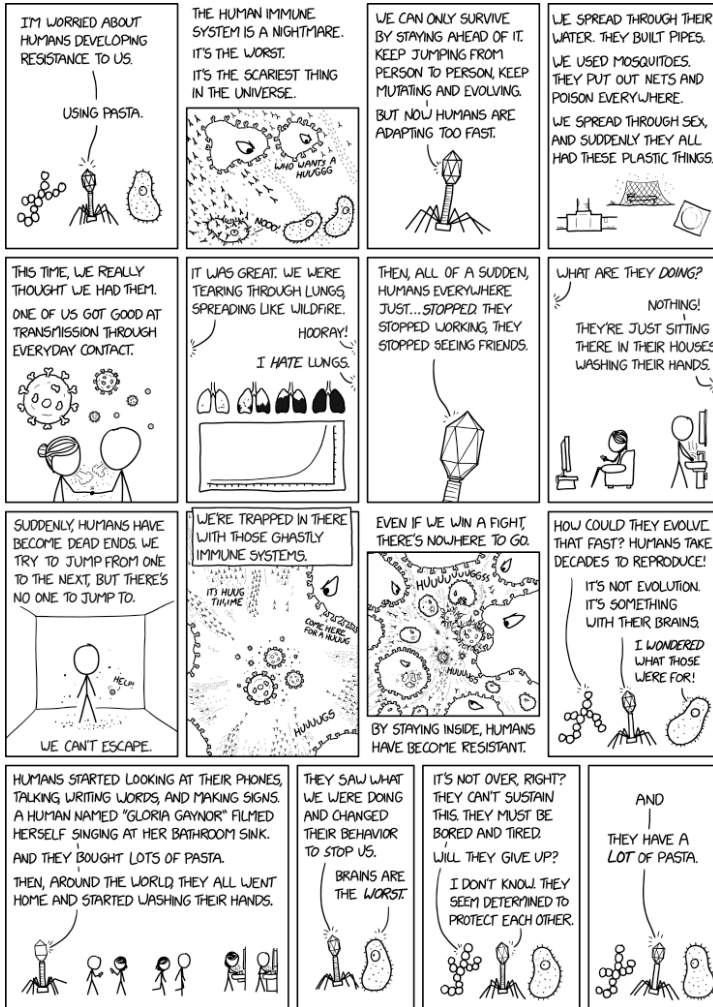
For comparison, only 21 countries have a population density  $>1000 \text{ mi}^{-2}$ , but there are a few cities with a population density on the same order of magnitude ( $\sim 100,000 \text{ mi}^{-2}$ ).

The USFS Equestrian Design Guidebook is (of course) a real thing, and it discusses the dimensions of the design horse

The title text is a pun using the alternate definition of foot by switching the naming from 6-foot zone, where foot is used as a unit of distance, to 34-foot zone, where the number represents the total number of feet inside the circle, including the horses' feet, assuming the human is endowed with the standard two feet and each horse has the standard four feet apiece.

# #2287: Pathogen Resistance

March 30, 2020



We're not trapped in here with the coronavirus. The coronavirus is trapped in here with us.

## Explanation

This comic is the 13th comic in a row in a series of comics related to the COVID-19 pandemic.

Rather than expressing humanity's fears and pessimism about the pandemic, this strip anthropomorphizes some of the pathogens which afflict humanity and presents their fears and pessimism about possibly going extinct. This serves as a roundabout way of expressing hope and wonder at the ingenuity and tenacity of humans in the face of diseases past (with water sanitation, mosquito netting, and condoms) and present (with the power of social distancing and Gloria Gaynor's hit song *I Will Survive*). Gaynor recorded a video of herself washing her hands for 20 seconds (the recommended length of time to wash hands for optimal cleanliness) to the background of her hit song.

The three pathogens presented are a virus (a bacteriophage), a small colony of a coccus-shaped bacterium (such as *Streptococcus*), and a protozoon (a caricature of a ciliate). Bacteriophages do not infect human cells (as the name suggests, they only infect bacteria), and have been studied for use as "phage therapy" for humans, especially in dealing with antibiotic-resistant bacterial infections (which is usually what people mean when they talk about "resistance" in the context of pathogens); however, they are iconic, instantly-recognizable viruses, and some have been found to collude with bacteria in forming certain

antibiotic-resistant biofilms. Only one kind of ciliate is known to cause human disease; however, ciliates are iconic for protozoa just as bacteriophages are for viruses (see, for example, Gary Larson's now-venerable *The Far Side* cartoons). The ciliate may be a 'stand-in' for protozoa that cause widespread and dangerous human diseases, such as malaria. The drawing is wildly out of scale; a protozoon is larger than a bacterium, which in turn is much larger than a virus.

"The scariest thing in the universe" to these microbes is the human immune system, represented in the second panel and later by antibodies (Y-shaped drawings) and anthropomorphized macrophages (actual macrophages do not have glaring angry eyes[citation needed]). When a T cell encounters an unfamiliar molecule in the body, such as the surface proteins of SARS-CoV-2, it will search for a B cell that produces a matching antibody. If and when it finds such a B cell, it will command the B cell to rapidly multiply and mass-produce antibodies. Those antibodies will then bind to any antigens they contact, which may impede the antigen (as shown by the tagged protozoon in panel 2 lagging behind its siblings) and will definitely mark them for destruction by macrophages, which engulf ("HUUGGG") and digest antibody-tagged objects they encounter. T cells can also be described as hugging cells, but a hug from a T cell is used to activate other processes, while a hug from a macrophage is a precursor to digestion. White blood cells are quite persistent once they have detected an antigen, even chasing them over many cell lengths in

what must be a terrifying experience for the antigen being chased.

The comic humorously considers pasta as an essential part of humans' fight against coronavirus. Pasta is an example of a dried food that can last a long time, if the orders to stay indoors continue, and was one of many products bought in mass quantities by shoppers "panic-buying" at the onset of lockdowns. Pasta is a popular dish in Italy, which is experiencing particular difficulties with COVID-19, but not every culture consumes or likes pasta. In addition, the Gaynor vid was initially shared via [soundpasta.com](http://soundpasta.com) among other services, and "pasta" is sometimes used to refer to sharing over the internet via cut-and-paste.

The colony of cocci protests that it shouldn't be possible for humans to evolve "pathogen resistance" in the short period of months since the breakout of COVID-19, when humans require over a decade to reach sexual maturity, and in modern times often wait at least two decades before having children. Humans develop immunity to some diseases after being infected, as some B cells become memory cells and are stored for quick re-activation in the case of a later infection, but this is not very effective against viruses which mutate rapidly, such as influenza and the common cold (which is sometimes caused by coronaviruses, although not SARS-CoV-2). Bacteria and viruses, on the other hand, reproduce in a matter of minutes, so that there may be hundreds of generations per day (comparable to the number of generations that have passed for humanity since the

beginnings of agriculture), each of which presents opportunities to evolve new antigens that are not recognized by any antibodies present in the body or to evolve resistance to whatever antibiotic drugs the host might be using. However, as the bacteriophage explains, humans generally do not become resistant against pathogens by genetic drift (although there are researchers who are seeking to identify genes that encode resistances to various diseases and then propagate them to other humans through gene editing, as in the He Jiankui affair). Instead, humans "evolve" pathogen resistance through behavioral changes. The behaviors presented in this comic strip include:

- Municipal water supplies, which are filtered and treated to prevent the spread of waterborne diseases, like cholera and dysentery.
- Mosquito netting over beds, and also anti-insect poisoning, to prevent the spread of vector-borne diseases, like malaria.
- Condoms (described as plastic in the comic, but more commonly latex rubber in real life), to prevent the spread of sexually-transmitted diseases, such as AIDS and syphilis.
- Social or physical distancing, hand-washing, storable food, and electronic communications, to prevent the spread of diseases through casual contact, like COVID-19.

These behaviors do not come from our genomes, passed along through reproduction, but from our brains, passed

along by communication. (This is meme evolution, the spread of ideas, where the mind selects what of the idea to pass along. Because of this memes can evolve spontaneously and unpredictably.) Some of the language of epidemiology is also used in discussion of communication, most notably "going viral" -- in this case, information is going viral to prevent viruses from going viral.

The title text reverts to the point of view of humans and references a famous line from the graphic novel *Watchmen*, where the vigilante Rorschach, whilst in prison and surrounded by enemies who want to kill him, proclaims: "I'm not locked up in here with YOU. You're locked up in here with ME." This presents an alternate perspective on quarantine and isolation that some may find more bearable: rather than passively hiding indoors in fear of the virus, we are taking action to fragment the virus population so that our immune systems (and medical intervention, in more serious cases) can defeat it in detail.

This was the at least first comic featuring pathogens as characters. The (at least) second is 2306: Common Cold.

## #2288: Collector's Edition

*April 03, 2020*



I'm sure you can find some suitable worldbuilding material if you scavenge through the archives.



## Explanation

This was the tenth April fools' comic released by Randall. The previous one was 2131: Emojidome from Monday April 1, 2019. The next became 2445: Checkbox released on Thursday April 1, 2021.

It is a large draggable image that acts as a shared virtual sandbox for users to interact. Chests are "Items" (small and often humorous images) which could be collected from other comics, and then placed in this image by viewers, but today they are no longer dropped. The collection then updated for all viewers in real-time. Multiples of the same item are often seen. There is a "backpack" at the bottom, similar to backpacks in video games containing items collected by the player. As hinted by the title text, items could be found by visiting different xkcd comics/pages. Randomly, some pages would have a treasure chest which contained the sticker related to the page. The hint would refer to the page which currently had a chest.

The comic contains 32993 separate images. The sticker images can be seen at [xkcd.com/2288/collectors/static/loot/loot\\_XXX.png](https://xkcd.com/2288/collectors/static/loot/loot_XXX.png), where XXX is a number from 001 to 253. Additionally, some images can be found at custom URLs, for example the periodic elements can be found at <https://xkcd.com/2288/collectors/static/loot/element-XX.png>, where XX is the element, and text loot at [xkcd.com/2288/collectors/static/loot/loot-words-X.png](https://xkcd.com/2288/collectors/static/loot/loot-words-X.png)

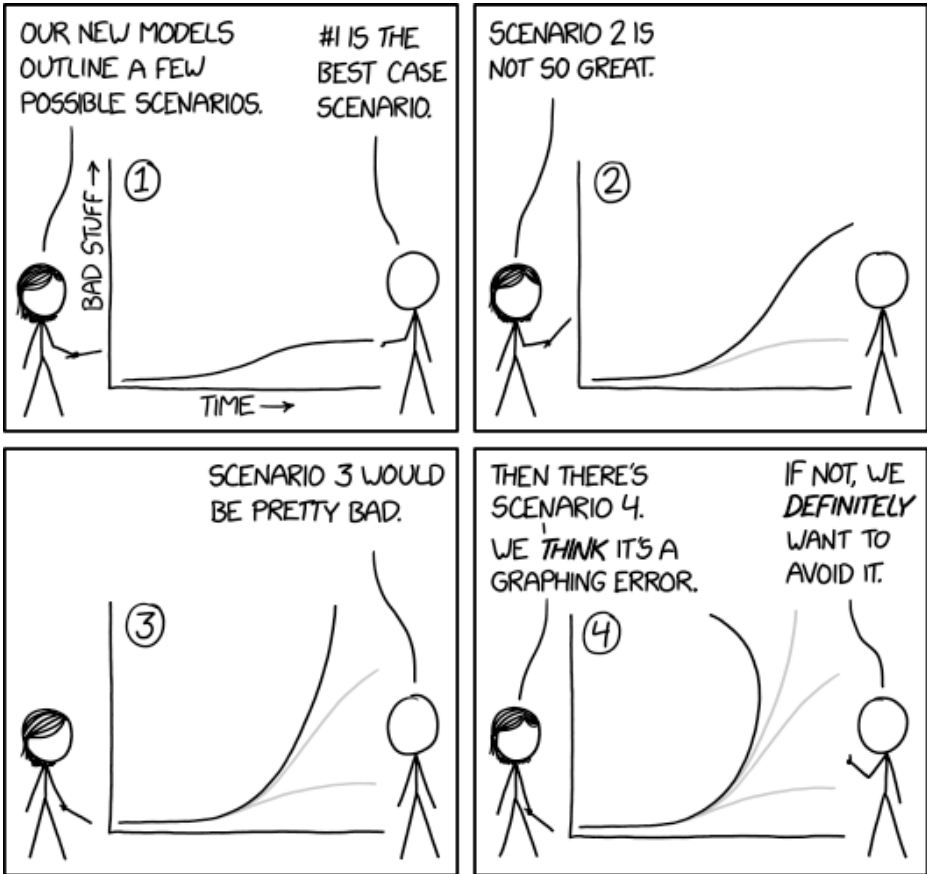
, where X is the sentence. The source code for the comic was released on GitHub.

Placement is limited to 10,000 horizontal units and 5,000 vertical units from the origin. Users received no messages if they try placing something outside the boundary, with a silent fail and the object not being placed. The coordinates are relative to the bottom left corner of the canvas. As the default coordinates are (-370,-277) and the origin is in the center, the displayed portion of the canvas can be found to be twice this in magnitude, 740 x 544 units. The most common image is loot-30.png, which appears 2576 times.

**Hints[edit]**

## #2289: Scenario 4

April 04, 2020



Remember, models aren't for telling you facts, they're for exploring dynamics. This model apparently explores time travel.

## Explanation

Although not directly mentioned, this comic is probably the 14th comic in a row (not counting the April Fools' comic) in a series of comics related to the COVID-19 pandemic.

In 2278: Scientific Briefing, Megan and Cueball were briefing White Hat on things that were getting bad, hoping to convince him to do something about them. He chose to wait until things actually got bad. Evidently, that has happened, and now Megan and Cueball are delivering another briefing on just how much "Bad Stuff" there might be, according to their models.

In the context of the information (and misinformation) explosion associated with the COVID-19 pandemic (ongoing at the time that this comic was published), many graphs have been shown highlighting the prevalence of the disease - the number of cases at any one time and place, and the change in the number of cases over time. That being said, the graphs shown could easily apply to any number of scenarios where an upward trend is bad.

Several of these graphs have attempted to predict the future, using statistical tools ("models") to process existing data and generate a forecast. Inputs to the model(s) may include different assessments of, for example, the number of COVID-19 cases that have been recorded. Four scenarios are presented here, presumably

showing what a particular model (probably only one despite the reference to "new models" in the comic) forecasts given different, unspecified, inputs.

Megan and Cueball present four scenarios, only three of which are possible.

- The first, "best case" scenario recalls "flatten the curve" graphs that predict an occurrence will eventually cease to increase altogether. Using COVID-19 as an example, if strictest measures are put into place and adhered to, all those who have contracted COVID-19 will eventually be reported, and no further victims will contract it.
- The second and third scenarios are increasingly worse cases, predicting that the occurrence will continue unceasingly. Again using COVID-19 as an example, the less measures are put into place or adhered to, the more COVID-19 cases that will occur. Scenario 3 appears to indicate an exponential increase best suited to a log scale; "pretty bad" is an understatement.
- The fourth curve is not possible[citation needed], as each point along the x-axis represents a specific time point. If the curve passes the same time point twice (as it does) then this means that on a given day there were two different number of cases. E.g. on the 1st of April there would have been both 100 and 1000 people infected, which makes no sense at all. The only way to make sense of it would be by using the common trope in science fiction of time traveling creating an alternate timeline in which events are different, thus the cases

could be 100 in one timeline and 1000 in a different timeline. Hence the remark, "this model explores time travel", in the title text. This is a brain cramp to visualize, and the consequences of it actually happening would be calamitous on several levels. Real modelers might encounter such "graphing errors" while they are developing their models, entering data (especially if there are time-conversion errors), and testing their functions, but persons who went so far as to present such glitches in public, except for a laugh as here, would likely be asked to hand in their modeler's cards.

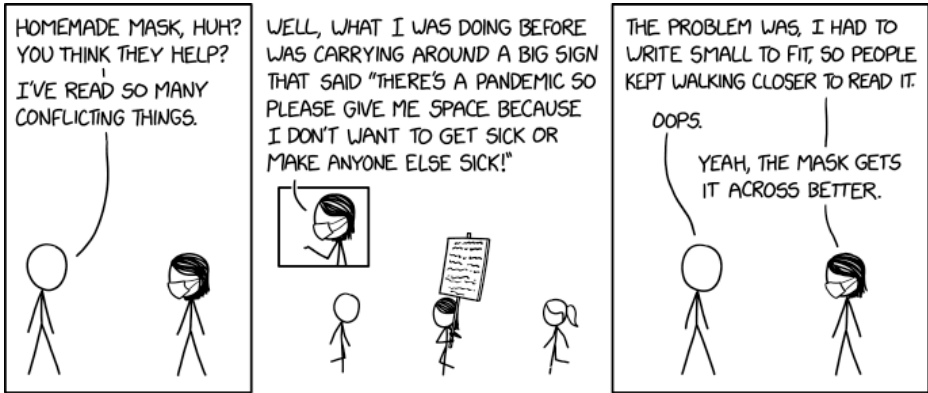
The 'time travel' remark is also suggestive of certain particle-physics phenomena captured in Feynman diagrams. Mathematically, an antiparticle moving forward in time looks like its equivalent particle moving backwards in time, so a particle-antiparticle annihilation or creation event could be interpreted as a single particle switching directions in time. In the context of this scenario, it is possible to read the fourth chart as predicting that the bad stuff will start traveling backwards in time as it increases, which we would see as a great quantity of "bad anti-stuff" appearing and decaying in number just as the "bad stuff" increases, until the two quantities meet at the halfway point and mutually annihilate. Even though there will be no more bad stuff after the annihilation (or time-reversal) event, particle-antiparticle annihilation releases enormous energies that might be even more catastrophic than whatever the bad stuff itself was.

A fanciful interpretation of this otherwise

uninterpretable graph is that the number of infections reached some sort of critical mass, breaking reality to begin spreading through time as well as space. Another possible interpretation may be that the number of infections become an imaginary number, as many of the common math graphs imply.

## #2290: Homemade Masks

*April 06, 2020*



I'm going to change the sign so the pole is horizontal and the sign is mounted on the front like a plunger, so I can carry it around like a lance to gently push people back if they try to approach.



## Explanation

This comic is the 15th comic in a row (not counting the April Fools' comic) in a series of comics related to the COVID-19 pandemic.

In this comic, Cueball wonders if Megan's homemade mask will be of any use, because he has seen many different points of view and is unsure which one is correct. It is generally agreed that homemade masks will not block particles (including droplets which carry viruses) as effectively as officially-tested N95-class masks or surgical masks, and possibly confer no benefit at all; however, wearing a homemade mask may reduce contagiousness if the wearer is infected, by blocking droplets from being expelled. It may also make the wearer less likely to touch their face (which may be a vector for catching COVID-19 from contaminated surfaces). On the other hand, there are concerns that it may confer a false sense of security, leading to unsafe behaviors, and that the warm, moist environment produced by the wearer's breath may also harbor incoming viruses, which may later infect the wearer if the mask is not washed frequently.

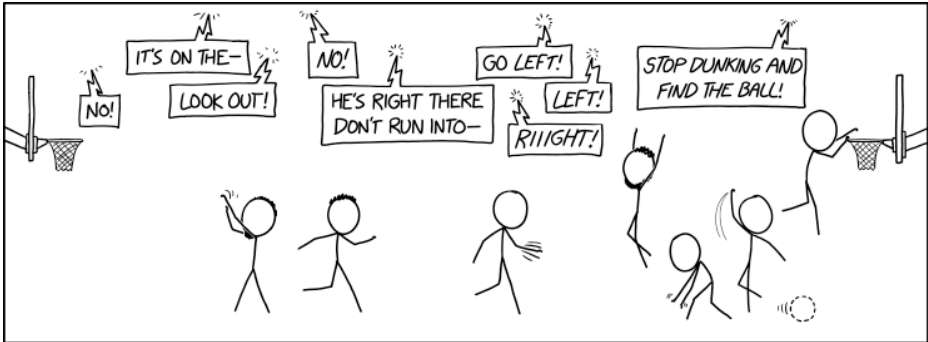
Megan replies that she originally carried a sign warning people to keep their distance, but people needed to get close to her to read it, making it counterproductive. The implication is that Megan's primary purpose in wearing the mask is to signal to other people that she's concerned about spreading COVID-19, and remind

them to keep their distance. Whether or not the mask has any direct benefits in blocking virus transmission, Megan apparently feels that the social impact of seeing someone in a face mask is likely to change behaviors, making transmission less likely.

The title text indicates an alternate method, where Megan could change the sign into a device for pushing people back in order to maintain distance. Holding the sign out in front of her (instead of over her head) would also let people get close to the sign to read it, without getting in her face.

## #2291: New Sports System

*April 08, 2020*



NO ONE LIKED MY NEW SPORTS SYSTEM, IN WHICH EACH PLAYER IS IN A SEPARATE ARENA SHARING A SINGLE VIRTUAL BALL THAT THEY CAN'T SEE WHILE ONLINE VIEWERS YELL INSTRUCTIONS, BUT IT WAS FUN TO WATCH WHILE IT LASTED.

Under my system, boxing and football suffered, pair figure skating still worked but had to adapt by dropping some moves, and pro wrestling was actually completely unaffected.

## Explanation

This comic is the 16th comic in a row (not counting the April Fools' comic) in a series of comics related to the COVID-19 pandemic.

As communities have been ordered to stay indoors to avoid spreading the virus, this has also affected sports leagues around the world, with many of them suspending their seasons, or cancelling them outright. (see this Wikipedia article for a full list of sports or sporting events impacted) Some leagues have instead promoted e-sports, such as the NBA holding an NBA 2K20 tournament between active NBA players.

Randall, in this comic, proposes an obviously bad "new sports system" of "virtual sports", in which players play with a virtual ball in separate arenas, and are guided by online viewers. This obviously proves to be challenging, as the ball is virtual but the players are not wearing any virtual reality or augmented reality headsets, and thus they do not know how to interact with it properly. Playing in separate arenas would solve the problem of spreading the virus, as the players do not have any direct interactions with each other.

This would be a similar system to Twitch Plays Pokémon, in which Twitch viewers "play" Pokémon video games in a crowdsourced manner. There are also many games that are intentionally constructed so that some players must accomplish a goal they cannot see or

with incomplete information, while they are guided by other players. These include common team-building exercises (often involving blindfolds), and the bomb-disposal themed puzzle game Keep Talking and Nobody Explodes.

The NBA also is holding a similar idea, holding a Horse tournament among NBA and WNBA players, which works better than the version of basketball shown in this comic because players don't need to interact with the same ball.

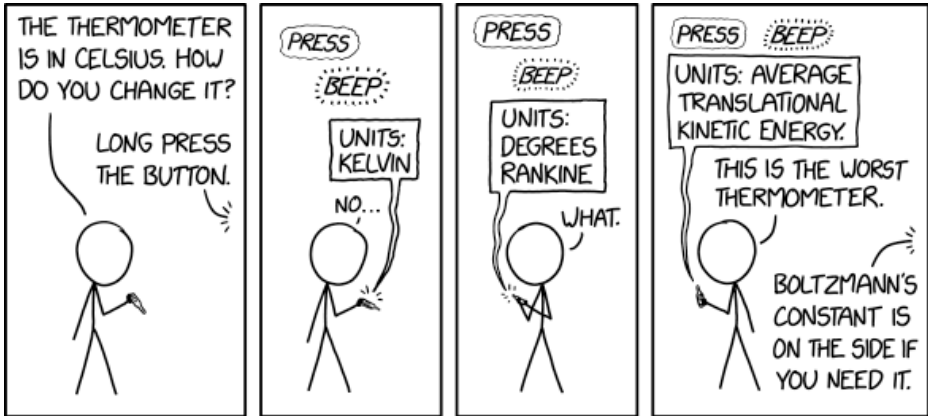
In the title text, Randall claims that boxing and football (he does not specify gridiron football or association football) proved to be difficult, with pairs figure skating still possible as long as figures like elevations are removed, and professional wrestling being unaffected. Boxing and gridiron football would be impossible to play in these situations; on top of the difficulty of trying to play without knowing where the other players are located, these sports are predicated on contact. A boxer cannot get a knockout without being able to touch the other players, and football players cannot block or tackle even if they mime catching the ball. Association football, with less emphasis on contact, might still be playable, but would suffer at least from the same complications as basketball shown here. Pairs figure skating would be possible, excepting "throwing" moves or "lifts", as typically pairs figure skaters skate in unison, replicating the same moves.

Humorously, Randall claims that professional wrestling

will be unaffected by his new system. This is in reference to the "open secret" that the matches have predetermined outcomes and are more "entertainment" than actual competition, with much of the 'forced' movement of one competitor being aided or even guided by the 'victim' rather than the 'aggressor' in semi-improvised feats of coordinated athleticism.

## #2292: Thermometer

April 10, 2020



I hate how many times you have to press it to get to the system normal people use, degrees Rmer.

## Explanation

This comic is the 17th comic in a row (not counting the April Fools' comic) in a series of comics related to the COVID-19 pandemic.

This comic expresses frustration at the multitude of temperature scales. Randall, as a former engineer, has strong opinions about units, as unit conversion is often a gripe for many engineers. (In a special preface in the UK edition of Randall's book *What If*, he mentions that one does not appreciate the metric system unless they have had to go through a bunch of scientific papers using really unusual units like "kilocubic feet per second" or "acre-feet".) As elevated body temperature is a symptom of COVID-19, the comic is thus also concerning the virus.

Cueball is holding what appears to be a medical thermometer, implying that he's trying to check his body temperature. He mentions that the thermometer is in Celsius, and asks how to change it. Many thermometers sold in the United States have settings for both Fahrenheit and Celsius, with an option to change between the two. Americans are almost always more familiar with body temperatures in Fahrenheit, so Cueball presumably expects to change to that scale. However, he finds that the thermometer provides measurements in a series of scales that are increasingly unhelpful. Normal human body temperature in Celsius is  $37^{\circ}\text{C}$ .



- Degrees Celsius are used in most of the world. The Celsius scale sets 0 degrees to water's freezing point and 100 degrees to water's boiling point. Few Americans have a clear idea of what normal and elevated ranges of human body temperature are in Celsius.
- Kelvin is a unit often used in scientific fields. It is calibrated on the same scale as degrees Celsius, but 0 K is set at absolute zero or  $-273.15^{\circ}\text{C}$ . This is used in scientific or engineering contexts requiring a thermodynamically absolute temperature, such as Charles's law, but almost never in a medical context, making the report of little use.
- The Rankine scale is another absolute scale, with its zero set at absolute zero, but degrees identical to degrees Fahrenheit. While this scale is still occasionally used in some industrial and scientific settings (being more convenient for absolute temperatures in a system including Fahrenheit), it's essentially never used in medicine, and most people have never heard of it.
- Thermodynamically, temperature is the average translational kinetic energy of a group of particles. Translational kinetic energy means it doesn't include rotational and vibrational kinetic energy. The relation between a gas's translational kinetic energy  $E$  and its temperature  $T$  is

Using these last three units for home temperature gauging would be ridiculous, as Kelvin and Rankine measurements of body temperature are unfamiliar to the average user and even those familiar with them would need to do calculations to translate normal body

temperature. Kinetic energy is obscure enough that only physicists, engineers and thermodynamicists, a relative handful of the potential buyers, would likely know what it refers to. Those that do could make use of the value printed on the thermometer, but such would add a great deal of unnecessary complexity to what should be a simple and intuitive task.

In the last frame Cueball calls the thermometer the worst. It seems to lack Fahrenheit entirely, frustrating its American consumer base, including Cueball. From a nerd's perspective this would be an extraordinary device, offering even exotic temperature scales. However, a "normal person" would find this thermometer terribly difficult to use for everyday purposes when set on any of the non-Celsius scales, like checking their body temperature or the temperature of food. As an item of consumer electronics, especially one sold in the United States, it would be almost completely useless.

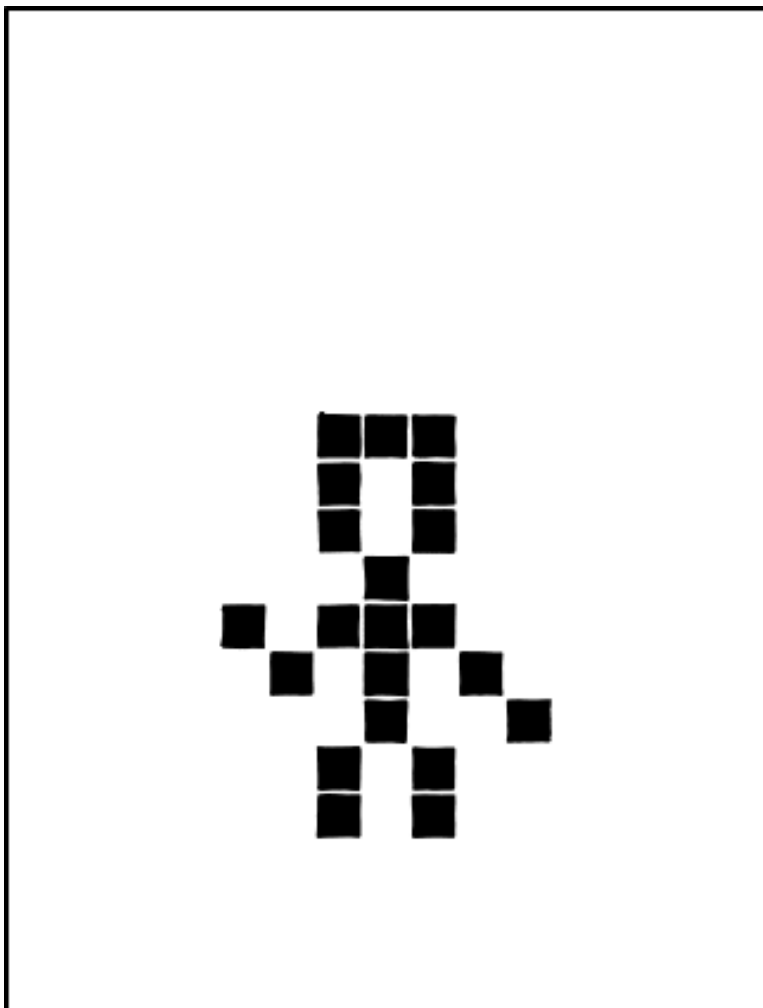
Deliberately lacking Fahrenheit is a jab against the imperial system of units, and against the similar but distinct system of United States customary units. Although imperial units and local traditional units are still used for various limited purposes (and/or by older generations) in different countries, most of the world has switched to using the metric system for most purposes going forward, with the US being relatively unusual in the extent to which it still routinely defaults to the US customary units in daily life. Many proponents of the metric system have long pushed for the US to change over, arguing that imperial and US customary units (and

degrees Fahrenheit, specifically) are archaic and obsolete. Randall has dealt with this conflict in other comics; as a physics major, he's partial to the metric system, and finds it frustrating to maintain multiple different scales (which is the basis of the conflict in this strip). On the other hand, he recognizes certain intuitive advantages to imperial and US customary measurements, and recognizes that the forces of social inertia in US society make change difficult.

The title text references an archaic temperature unit, Rømer (°Rø), first proposed in 1701. It is the common ancestor of both the Celsius and Fahrenheit scales, defining the freezing point of water as 7.5 degrees and the boiling point of water as 60 degrees. Unlike the other measurements mentioned in this strip, the Rømer scale is no longer used in any context, and only people interested in the history of temperature scales have any idea that it even exists. This is the ultimate form of obscure and outdated temperature measurements.[citation needed]

# #2293: RIP John Conway

*April 13, 2020*



1937-2020

## Explanation

John Conway, an English mathematician, passed away of COVID-19 on April 11, 2020. (Alternative link) Two days later, Randall created this memorial comic. It is the 6th memorial comic, but it is the first released in almost 5 years, since 1560: Bubblegum.

One of Conway's most famous creations was the cellular automaton known as Conway's Game of Life. A cellular automaton is a machine composed of cells, each of which can be in a different state. Every generation, each cell in the automaton may transition to a new state depending on a set of rules. (Conway's work in mathematics was vast and various, but he is perhaps best known in the field for discovering the surreal numbers, which inspired Donald Knuth to write a novel which may have been referenced back in 505: A Bunch of Rocks.)

Conway's Game of Life was first popularized to the general public in the form of a game, Life Genesis, bundled into some distributions of Windows 3.1, an operating system from the early-90s that Randall most likely used in his preteen years.

Conway's Game of Life is a 2-state automaton (i.e., every cell can be "alive" or "dead") that is implemented on a two-dimensional grid of cells using the Moore neighborhood - this means that each cell can only be influenced by the eight cells directly surrounding it, both orthogonally and diagonally. The transition rules that

Conway used are as follows:

- If an "alive" cell has no live neighbors, or only one live neighbor, it becomes "dead". (This simulates death by isolation).
- If an "alive" cell has four or more live neighbors, it becomes "dead". (This simulates death by overcrowding).
- If a "dead" cell has exactly three live neighbors, it becomes "alive". (This simulates birth).

Despite the simplicity of these three rules, Conway showed that patterns of amazing complexity can nonetheless develop out of simple cell arrangements. Some patterns do not evolve at all ("still lifes"), some enter a cyclic, repeating state ("oscillators"), and some reproduce their own pattern displaced by an offset, resulting in patterns that can move across the grid under their own power ("gliders" and "spaceships"). This last category is of particular interest, as it allows the Game of Life to transmit information from one location to another, allowing for rich, dynamic behavior and even for the creation of computational machines within the automaton itself.

This comic begins with the shape of a stick figure as the starting cell configuration of the Game of Life. The black cells are "alive" and the white cells are "dead". This configuration then evolves via Conway's rules, disintegrating into nothingness except for a five-cell pattern known as a "glider", which ascends up and to the

right. This visually suggests an eternal "soul" breaking away as the corporeal body disintegrates. The glider is perhaps the most iconic pattern of the Game of Life, and is often used symbolically to represent the phenomenon of emergence.

Here the topology of the grid on which the cells evolve is not known, the cellular automaton can be run on many topologies, for example you can choose to make cells reappear from the opposite side once they reach an edge (similarly to the behaviour of the well known Pacman). Here once the glider reaches the top right, we know for sure that the actual grid is bigger (since the glider leaves the frame while continuing its pattern), and we are only seeing part of the full grid.

The initial state presented in the comic does actually evolve in that manner, as can be verified by entering the pattern into a cellular automaton simulator such as Golly or web services such as this one or that one. It seems that no one else have created this pattern before. At least, despite discussion in the comments, no one has found anything to show that this is not Randall's own discovery of this pattern.

The title text simply states Conway's birth and death year: 1937-2020.

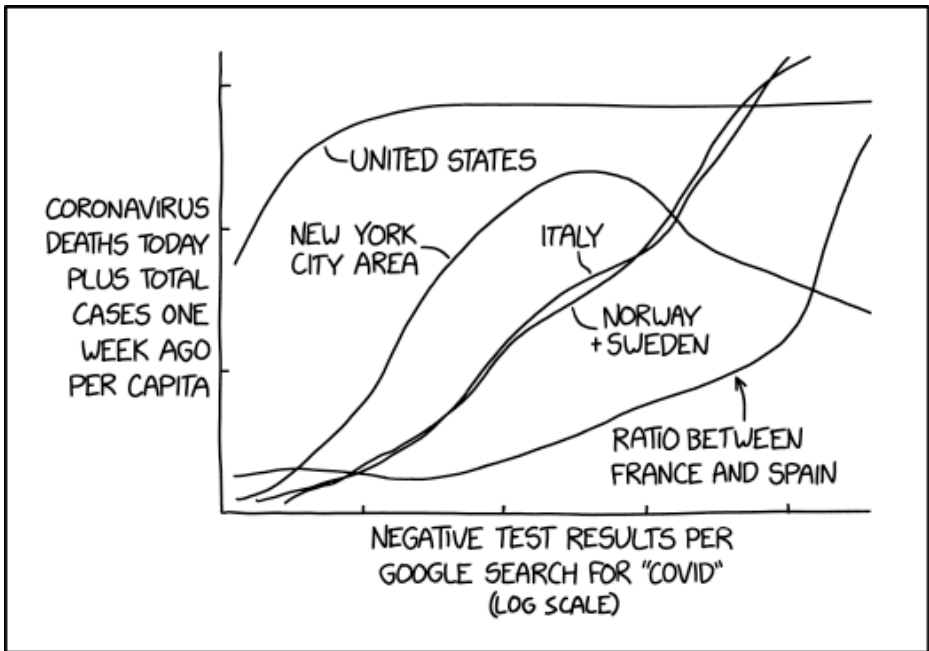
Conway's Game of Life was previously mentioned in 696: Strip Games. Cellular automata was also referenced in 505: A Bunch of Rocks.

This comic is the 18th comic in a row (not counting the April Fools' comic) in a series of comics related to the COVID-19 pandemic. Although this comic is, of course, mainly a tribute to John Conway, the fact that he died of COVID-19 in the middle of this long series of coronavirus-related comics by Randall is relevant.



## #2294: Coronavirus Charts

*April 15, 2020*



I'M A HUGE FAN OF WEIRD GRAPHS, BUT EVEN I ADMIT SOME OF THESE CORONAVIRUS CHARTS ARE LESS THAN HELPFUL.

Adding data for South Korea but with their cases scaled to match the population of Japan and the land area of Australia, and vice versa.

## Explanation

This comic is the 19th comic in a row (not counting the April Fools' comic and the previous tribute comic) in a series of comics related to the COVID-19 pandemic.

During the current outbreak of COVID-19, there have been many graphs used by health officials and others to show trends in infection and death rates. Their x-axis is usually time. The curves might represent different countries or different mitigation strategies. But

health officials and media have struggled to decide what to put on the y-axis. Because testing strategies and reporting are so variable across even small regions, their data does not reflect comparable guesses at the true number of cases. So they produce graphs of confirmed cases, confirmed plus suspected cases, deaths, hospitalizations, any of the above per capita, day-to-day changes in any of the above, and share of test results that are positive for different areas of New York.

This graph, however, while sharing similarities with actual data and graphs is completely useless. This is due to the bizarre data-points being used, as well as the unhelpful graph axes. The caption of the comic notes as much, perhaps indicating that this comic is intended to satirize the useful, but exceptionally detailed graphs that are currently in use. Some of these graphs have a semilog scale, like this graph - but generally the y-axis is the log scale and the x-axis is not. Sometimes the other graphs compare things of vastly different sizes - as demonstrated

by showing both the USA and New York. Sometimes they scale the data to population, as referenced by the title text.

In addition, the selection of geographic areas used here is incomprehensible. Two of the lines represent countries (USA and Italy), and another represents part of one of those countries (New York City area). The New York City area may have been chosen because it has a very large number of cases, more than some countries. However, a fourth line combines Norway and Sweden -- two countries which are culturally, economically, and geographically similar but have imposed very different strategies regarding closing businesses and schools. Combining Norway and Sweden obscures any differences attributable to their different policies regarding the virus. A fifth line represents not a geographical area but the ratio between France and Spain, making an already meaningless graph even less comprehensible.

The title text adds a further ambiguity: Usually, there are only two items being compared in a "vice versa" (e.g. "Would you rather have live in a city with the land size of San Francisco and the population density of Tokyo, or vice versa?" when comparing two other cities with those measurements); here there are three, leading to either ambiguity (possibly two South Korea lines, each based on one of two complementary sets of cross-demographic refactoring), or six lines being embodied in that "vice versa".

## Other metrics used

### X-axis:

- Negative test results: Negative test results would refer to people who were tested for COVID-19, but who do not have the disease (or were not able to confirm having the disease). If there are any places reluctant to test, in order to artificially suppress the unpopular number of positives, this measure would similarly be unreasonably low. It might therefore be an important key measure, used as just one component of a meta-measurement, to regrade or even highlight such practices. At least until the figures are freshly massaged by instead overtesting people with a low probability of being infected.
- per Google search for "COVID": Meanwhile, Google search results for "COVID" are search hits for that word. There is no relation between these two, and furthermore, it does not make sense for this to be graphed on a logarithmic scale.
- As mentioned above, the x-axis for most charts is time, as it is valuable to know how the virus or deaths are spreading over time. Negative test results should grow over time, but may not grow uniformly depending on availability of tests, and some may later be invalidated as testing methodologies are refined. Given that and depending on the trends in Google searches for COVID, it's entirely possible for multiple points in time to map to the same value of x (although none of the curves shown here do, Scenario 4 from 2289: Scenario 4 did).

Y-axis:

- Coronavirus deaths today: Deaths from the coronavirus "today" are constantly reported by the media, and could be a helpful metric in seeing whether the virus is spreading or not, if deaths "today" are compared to deaths yesterday and previous days.
- Total cases one week ago: This is a much larger number than deaths and will completely dominate the sum. Cases one week ago might have some predictive value for deaths today or in the near future, but adding them together double-counts many cases.
- Per capita: This is a measure of the amount per person, and is useful for averaging out numbers based on population size. For example, the United States have the most publicly-reported COVID-19 cases and deaths, but also has the third-largest population of all countries, so using per capita numbers tells a different story.

Title text: While adding data for South Korea might be helpful (as it shows an Asian country, compared to just Europe and the US), it is only logical to scale the data to the population of another country (e.g. Japan) if you're actually comparing the two countries (i.e. does Japan have more or fewer cases per capita than South Korea). Scaling cases based on land area is much less useful; it's true that countries with lots of land area, like Australia, do have lower population densities, which affects the spread of disease, but most of the people in Australia live in higher-density cities on the coast, so the actual change

is not that great.

## #2295: Garbage Math

*April 17, 2020*

$$\text{PRECISE NUMBER} + \text{PRECISE NUMBER} = \text{SLIGHTLY LESS PRECISE NUMBER}$$

$$\text{PRECISE NUMBER} \times \text{PRECISE NUMBER} = \text{SLIGHTLY LESS PRECISE NUMBER}$$

$$\text{PRECISE NUMBER} + \text{GARBAGE} = \text{GARBAGE}$$

$$\text{PRECISE NUMBER} \times \text{GARBAGE} = \text{GARBAGE}$$

$$\sqrt{\text{GARBAGE}} = \text{LESS BAD GARBAGE}$$

$$(\text{GARBAGE})^2 = \text{WORSE GARBAGE}$$

$$\frac{1}{N} \sum (\text{N PIECES OF STATISTICALLY INDEPENDENT GARBAGE}) = \text{BETTER GARBAGE}$$

$$\left( \frac{\text{PRECISE NUMBER}}{\text{NUMBER}} \right)^{\text{GARBAGE}} = \text{MUCH WORSE GARBAGE}$$

$$\text{GARBAGE} - \text{GARBAGE} = \text{MUCH WORSE GARBAGE}$$

$$\frac{\text{PRECISE NUMBER}}{\text{GARBAGE} - \text{GARBAGE}} = \text{MUCH WORSE GARBAGE, POSSIBLE DIVISION BY ZERO}$$

$$\text{GARBAGE} \times 0 = \text{PRECISE NUMBER}$$

'Garbage In, Garbage Out' should not be taken to imply any sort of conservation law limiting the amount of garbage produced.

## Explanation

This comic illustrates the "garbage in, garbage out" concept using mathematical expressions. It shows how, if you have garbage as inputs to your calculations, then you will likely get garbage as a result, except when you multiply by zero, which eliminates all uncertainty of the result.

The propagation of errors in arithmetic, other mathematical operations, and statistics is described in colloquial terms. Numbers with low precision are termed garbage, while numbers with high precision are called precise. The table below quantifies the change in precision from the operands to their result in terms of their variance, represented by  $\sigma$ , the Greek lowercase letter sigma, equal to the standard deviation, or the square root of the variance. Variance or standard deviation are common specifications of uncertainty (as an alternative to, for example, a tolerance interval.)

The accuracy and precision of mathematical operations correspond to the rules of propagation of uncertainty, where a "garbage" number would correspond to an estimate with a high degree of uncertainty, and a precise number has low uncertainty. The uncertainty of the result of such operations will usually correspond to the term with the highest uncertainty. The rule about  $N$  pieces of independent garbage used to calculate an arithmetic mean reflects how the central limit theorem predicts that the uncertainty (or standard error) of an



estimate will be reduced when independent estimates are averaged.

The title text refers to the computer science maxim of "garbage in, garbage out," which states that when it comes to computer code, supplying incorrect initial data will produce incorrect results, even if the code itself accurately does what it is supposed to do. As we can see above, however, when plugging data into mathematical formulas, this can possibly magnify the error of our input data, though there are ways to reduce this error (such as aggregating data). Therefore, the quantity of garbage is not necessarily conserved, in contrast to other scientific quantities like energy and momentum that are always conserved. Alternatively, this could be taken as a pun on environmental conservation efforts, which can often involve recycling one's trash. However, the computer science maxim of "garbage in, garbage out," has nothing to do with actual garbage.

## #2296: Sourdough Starter

*April 20, 2020*



THEORY: THE CORONAVIRUS IS A  
YEAST SYMBIONT WITH AN *EXTREMELY*  
CONVOLUTED PARASITIC LIFE CYCLE.

Once the lockdown is over, let's all get together and swap starters!

## Explanation

This comic is another comic in a series of comics related to the COVID-19 pandemic.

Recently, because of the coronavirus, many people are forced to stay home in quarantine or under Stay-at-home orders. These conditions often lead to spare time that needs to be filled, and many people have turned to baking, which can usually be done entirely at home, is relatively time-consuming, and has the advantage of producing finished food, lessening the need to go out to buy food. This trend is common enough that baking supplies, including yeast, have seen a spike in demand, to the point where many people have trouble finding it.

As an alternative to yeast, consumers can grow their own sourdough starter, which is a symbiotic culture of yeast and bacteria naturally found in flour. Once the starter has matured, part of it can be used to make bread or other baked good rise, while the remainder can be mixed with more water and nutrients to allow the remaining yeast and bacteria to multiply once again. Because these populations need to be maintained, it's often been a practice to trade starters from house to house, with each home using starter when they need it, then setting up the remaining starter to breed more. This has historically been a social activity, allowing people who share an interest in baking to meet, share recipes, and spend time together.

The upshot of all of this is that the coronavirus pandemic has created conditions in which yeast (and symbiotic bacteria) are being bred in larger numbers, both by companies trying to fill demand, and by individuals trying to make their own. The joke is that this outcome is, in fact, the entire purpose of the coronavirus, which is in a symbiotic relationship with yeast. The entire global pandemic, by this logic, is directed to keep humans indoors and baking so that more yeast (and bacteria) is bred. The practice of swapping sourdough starters means that they're propagated more widely, increasing and distributing the yeast population (while potentially giving the virus more opportunity to spread, as people socialize).

As Randall points out, this cycle is extremely convoluted.

However, it is not unknown for parasites to drive the responses of other creatures in order to propagate themselves. For example, *Toxoplasma gondii* infects mice, but can only reproduce when it infects cats. The organism has therefore adapted to infect the nervous systems of mice, making them extremely reckless, increasing their odds of being caught and eaten by cats, allowing the parasite to move to a new host. Some flatworm parasites have very complex life cycles that involve four different host animals.

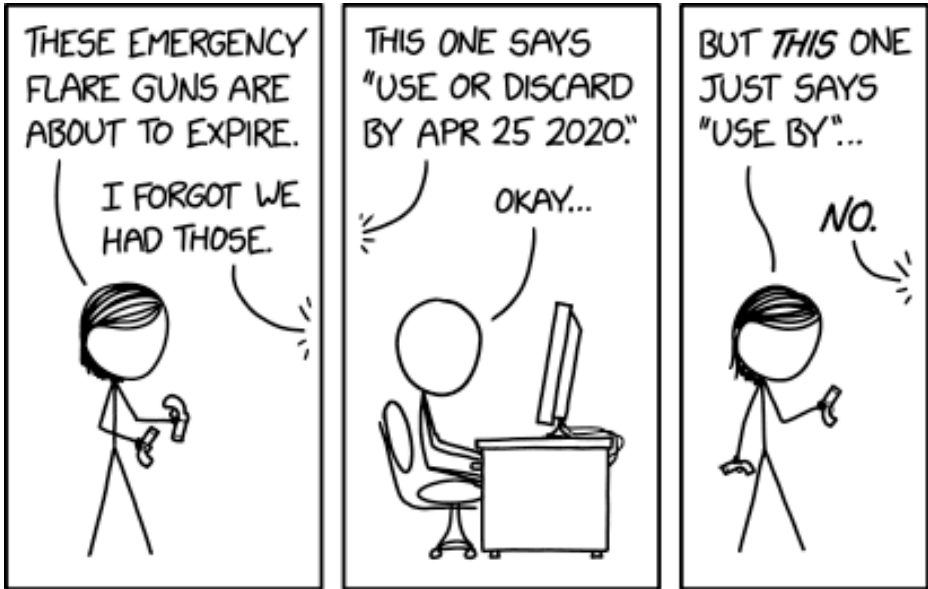
Randall has previously speculated about unusual parasitic organisms in 2246: Christmas Presents, in which he "concluded" that Christmas presents are parasites of Christmas trees, possibly mediated by a fungus. And in 1664: Mycology a fungus infects human

brains making them wish to study (and thus grow more of) this fungus.

Viruses are not organisms (lacking some of the defining features of life), and it is debatable whether they would be considered parasites. Moreover, this theory is obviously implausible for a number of reasons. The most obvious being that natural responses, particularly of viruses and simple organisms, evolve over a long time scale. SARS-CoV-2, the virus responsible for the current pandemic, has very likely been infecting humans for less than one year, certainly not long enough to evolve such a complex set of behaviors. At the same time, a symbiotic relationship would require yeast to somehow contribute to the life cycle of the coronavirus in a meaningful way, which is unlikely when the yeast is being artificially bred in isolated containers. If however, as suggested by the title text, people getting together to swap yeast starters after the lockdown ends does cause the virus to begin spreading in humans again as a result of the social contact, then the yeast would be contributing to the life cycle of the coronavirus, in an equally convoluted way. The humor, therefore, is derived from the fact that this is a comical exaggeration, but based on cycles that actually do happen in nature.

## #2297: Use or Discard By

*April 22, 2020*



One of the things of bear spray says that, and I'm not one to disobey safety instructions, but there are no bears around here. Guess it's time for a camping trip where we leave lots of food out!

## Explanation

Many products carry a "Use By", "Expiration date", "Discard by" or similar date. The date shows the latest date by which the product has been verified to provide its expected use. For example, a foodstuff will have a "consume by" date, showing the date after which the food may be unsuitable for eating. In most cases, this will be a conservative estimate, and the useful lifetime can be significantly extended by proper storage.

One of the issues around expiration dates is that the language used is decided on by the manufacturer, making them highly variable and often ambiguous. Some have explicit instructions to the consumer, such as "use by:", others have instructions to the seller, such as "sell by:", still others say things such as "best by:" or "freshest before:". This can make it confusing how important it is to avoid using a product past a given date.

For many consumer goods, the expiration dates are of minimal importance, and using them afterward risks nothing more than a drop in quality. In certain cases, however, they can have safety implications. Some foods, if kept too long, become dangerous to consume. Medications can lose their potency over time, and relying on them past the expiration date could put a person's health at risk.

In this comic, two similar emergency flare guns, an item typically used to send out distress flares, have slightly

different expiry instructions. One has an instruction to "use by or discard by" a specific date (in this case, three days after the date of publishing). The other has an instruction to "use by" this date. These two phrases almost certainly have the same intent. The older flares are, the less reliable they become, so the manufacturer recommends regularly replacing unused flares with working ones, to ensure that working flares are available in case of an emergency.

Megan, however, seems to take the latter instruction literally, as an order to actually fire the flare gun prior to the expiration date, whether or not it's necessary. It may be taken that she wants the experience of firing a flare, and takes that instruction as an excuse to do so. Cueball immediately objects to this line of reasoning. Firing a flare unnecessarily is generally a bad idea. It could summon emergency responders to a non-emergency situation, diverting emergency resources that may be needed elsewhere. Even worse, if a flare is fired improperly, or in an unsafe direction, it could cause a fire and/or injuries, ironically creating an emergency situation, rather than signaling one.

The title text similarly indicates that Megan encountered similar instructions on a can of bear spray. Since there are no bears present, she intends go camping and leave her food out to attract bears, so that she may use the bear spray to repel them before it "goes bad". Clearly, this would be a bad idea. While bear spray is a useful emergency measure, there are many reasons why it could fail to protect the user, which would risk severe injury or

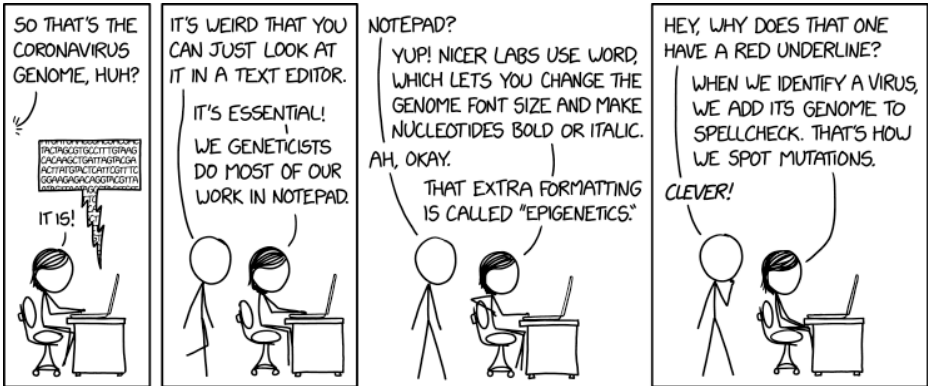


death. Even if the bear spray effectively protected Megan, deliberately baiting wildlife so that you can repel them with a painful irritant would be irresponsible and cruel. In both cases, the humor derives from the language that appears to instruct the use of an emergency product, even if no emergency has occurred. In both cases, taking such instructions literally would risk causing injuries, rather than preventing them.

Expiration dates (for food) have also been mentioned in 737: Yogurt, 1109: Refrigerator, and 2178: Expiration Date High Score.

## #2298: Coronavirus Genome

*April 24, 2020*



Spellcheck has been great, but whoever figures out how to get grammar check to work is guaranteed a Nobel.

## Explanation

This comic is another comic in a series of comics related to the COVID-19 pandemic.

It was also the first in a new series, followed in the next comic by 2299: Coronavirus Genome 2.

Megan is a geneticist doing research on the SARS-CoV-2 virus. She is analyzing the virus's genome, its genetic material composed of RNA. The genomic sequence can be represented as a list of nucleotide bases (guanine, adenine, cytosine, thymine and uracil - often abbreviated as G, A, C, T, and U).

The nucleotide sequence displayed is a 100% match to six SARS-CoV-2 sequences in public databases, all of them originating from the East Coast of the United States. The sequence is from nucleotides 26202-26280 of the virus genome and overlaps an unknown open reading frame/gene named ORF3a. One of the matching sequences is . However, SARS-CoV-2 is an RNA virus, and so its genetic material (not containing any DNA) would not include thymine (T) but would use uracil (U) instead. The sequence uses the codes of DNA as RNA sequencing involves copying the genome into a DNA, and the DNA code is more familiar anyways.

Cueball is surprised that Megan and her colleagues actually use Microsoft Notepad, a simple text editor, to look at the genome, instead of more modern technology.

She explains that better research institutions use Microsoft Word, a more advanced editor, to allow additional formatting (such as bolding and italics), and humorously calls this "epigenetics". In the real world, epigenetics is the study of changes that are not caused by changes in nucleotides, but by chemical modifications of DNA or chromosomes that cause changes in patterns of gene expression and activation, sometimes several generations down. This might be considered analogous to altering the meaning of a text by changing its formatting rather than the content; for example, content can be moved into parentheses or footnotes to be de-emphasized, or rendered in boldface or enlarged to attract attention and emphasize key points. Much as text can be wrapped in HTML tags or similar markup to change its formatting, nucleotides can be methylated to prevent transcription, and the histones around which DNA is wound can also be modified to promote or repress gene expression. During DNA replication, these modifications are often also reproduced.

The real punchline comes when Megan uses spellcheck to detect mutations in the genome by adding the previous genome to spellcheck and comparing them. Overall, Megan uses ridiculously and humorously crude methods to analyze a major genetic item. The genome of SARS-CoV-2 is almost 30,000 base-pairs long, which exceeds the longest words of any natural language by two orders of magnitude (the longest words ever used in literature -- i.e. not constructed in isolation simply for the purpose of being a long word, or chemical formulas --

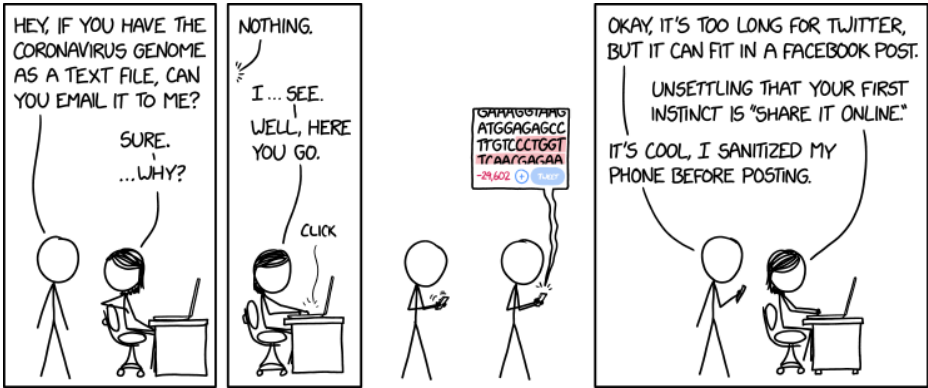
approach 200 letters), and may exceed the capabilities of any available spell-checking program. Furthermore, a spellcheck program underlines the whole word if a single letter is wrong and not just the letter itself. Thus, it would not be able to highlight individual mutated base pairs. Megan might be better served by using a diff tool, but most scientists generally use commercial software that is designed to view, annotate, and edit DNA sequences (eg: Snapgene, Geneious, DNASTrider, ApE).

The title text mentions grammar checking and claims that whoever discovers how to use that to compare genomic material should be awarded a Nobel Prize. Spell-checking is analogous to comparing sequences against ones previously known, an activity that is the bread and butter of bioinformatics nowadays. Grammar checking would be analogous to having some sort of sense as to how well all the sequences generally cooperate and interact to create possibly viable functionality in an organism, something we are unable to do at the moment except in very limited ways and only in a few simple cases. It may also be a snarky commentary on the untrustworthy nature of grammar-check programs in general, which often follow grammatical rules far more strictly than is practical; it's not uncommon for an author to follow a grammar-check recommended correction only to find the corrected portion is now part of a longer portion that the checker deems "incorrect".

Amusingly, this and the title text foreshadowed the usage of an MIT language learning algorithm to predict mutations in SARS-CoV-2.

## #2299: Coronavirus Genome 2

April 27, 2020



[moments later, checking phone] Okay, I agree my posting it was weird, but it's somehow even more unnerving that you immediately liked the post.

## Explanation

This comic is another comic in a series of comics related to the COVID-19 pandemic.

It is also a direct continuation of the previous comic, 2298: Coronavirus Genome, making this a new series.

Megan sent her copy of the coronavirus genome to Cueball, who then proceeded to share it with his friends on social media. In effect, he is spreading the virus over the Internet, though not in a form that can actually make people sick with COVID-19 (which may seem obvious, but then some people believe 5G causes coronavirus.) If his post catches on and is widely shared, it might be described as "going viral". (This "virtually" spreading the coronavirus, would be a prank).

Additionally, while exchanging research data generally is as good an idea as using readymade tools for science, publishing the genome of a dangerous virus actually might cause the virus to spread further: There are specialized manufacturers that can mail you arbitrary DNA snippets if you send them their sequence as an ASCII file. That actually can work in the other direction, too: Some of the machines used by such firms in order to save space stored a base pair in 4 bits of memory and could (using a buffer overrun) be convinced to actually try to execute instead of manufacturing the DNA code.

In continuation of the previous strip, Cueball appears to be fascinated by the fact that the entire genome of this

very consequential virus can be fully detailed in a text file, using only 30,000 characters. He realizes that he can't fit this much information in a single tweet (Twitter has a 280 character limit), but is able to fit the entire genome in a Facebook post (Facebook allows up to 63,206 characters in a post).

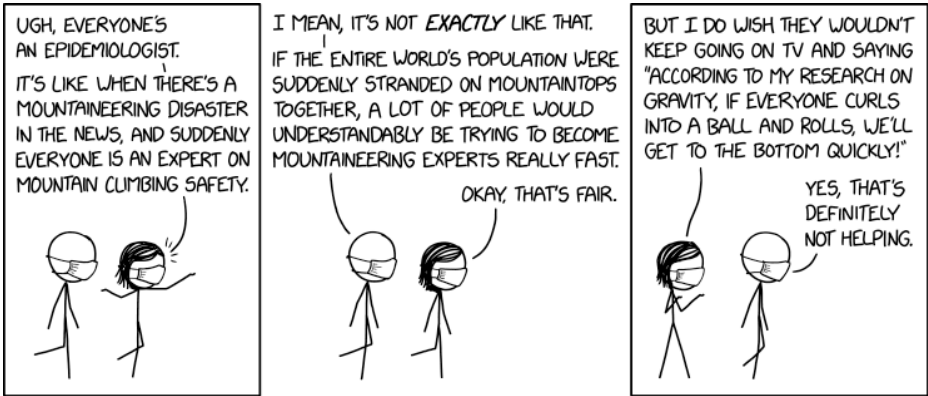
This strip draws humor from the contrast between the costly physical precautions that are being taken to prevent the spread of coronavirus between people and the blitheness with which Cueball attempts to share (the genome of) the coronavirus electronically. Cueball's response (that it's okay, because he sanitized his phone before posting) could be taken as a sarcastic rebuttal, given that Megan sent the genome to him without knowing why he wanted it, or a commentary on the useless or counterproductive behaviors of clueless people (e.g. people who wear gloves before touching potentially-contaminated surfaces, but then scratch their noses while still wearing the possibly-contaminated gloves). It could also be a reference to the Hitchhiker's Guide to the Galaxy series, in which humanity is revealed to possibly be the descendants of the "useless" occupants of the planet Golgafrincham, including telephone sanitizers; unfortunately, after sending their useless members to the planet later called Earth, the remaining Golgafrinchans were subsequently wiped out by a plague caught from an unsanitized telephone. This may also be a reference to the concept of digital data sanitization (the screening of user inputs to prevent exploitation of security flaws) as in 327: Exploits of a Mom.



The title text deals with the almost inevitable outcome of the resulting message being 'liked' by some other party. In this case Megan, although she just told Cueball it was weird that he shared it. This may be a commentary on the common reflex to "like" your friend's posts, even if you think they're strange. Alternately, the "like" button on Facebook was historically the only way to signal a reaction to a post (other than actually commenting). When someone posted about a bad event, such as an injustice, a tragedy, or a difficult personal event, people might "like" the post to indicate their support of the person posting it, but it could read as having positive feelings toward the incident itself. (Facebook has since added multiple reaction buttons to express such emotions as surprise, sadness or anger). In this case, Megan "like"ing the coronavirus genome could be taken to mean that she likes the virus itself, which would be quite odd.[citation needed]

## #2300: Everyone's an Epidemiologist

April 30, 2020



If enough people uphill decide to try the rolling strategy, they can make the decision for you.

## Explanation

This comic is another comic in a series of comics related to the COVID-19 pandemic.

Megan complains that the sudden rise in awareness of COVID-19 has led to many people that act as if they are epidemiologists; i.e. experts on the issue of global policy and the virus's traits, while in fact most are just repeating what they have heard from various news outlets, which do not always get everything right. She compares the situation to people who are suddenly expert on mountain climbing safety every time a mountaineering disaster hits the news - and uses an analogy of Joseph Beuys' "Everyone is an artist" for saying that.

Cueball notes that her analogy fails to account that everyone is directly affected by the virus, meaning that everyone should be educating themselves on the topic as much as possible, similar to how if everyone was stranded in mountains all at once, lots of people would try to become experts as fast as possible.

Megan acknowledges this fact, but continues the mountaineer analogy to the virus saying that she wishes those that now think they are experts would at least not go out on TV saying they found out that everyone would come down fast if they just curl up in to balls and roll down because their "research on gravity" says they will get to the bottom quickly, which Cueball agrees.

In corona pandemic terms, this is probably a reference to those that claim we need to get out of lockdown as fast as possible, to save the economy (the closure of which has its own costs, potentially including losses of life through e.g. depression, homelessness, displacement, and so on), and maybe to induce herd immunity (SARS-CoV-2 does not mutate as rapidly as e.g. the influenza family of viruses, so it is hoped that individuals who are infected and survive will develop long-term immunity, and that a single vaccine will be very broadly effective, but this is still not known for certain as of this writing). But those are not considering all the lives at stake, which is what frustrates Megan. Who should decide that those with weak immune systems should be placed in such grave risk, for the better of the economy? Maybe not the every-man who has read something on the internet... which could be wrong, see 386: Duty Calls.

The title text explains how the decision may not even be yours; if those who were in more precarious positions above you now start to hit you on the way down and cause you to tumble as well, you will also end up as one of those rolling downhill. And in pandemic terms - if enough people ignore the precautions, then it will be much harder for the rest to avoid getting the disease, which will cause more deaths.

The rolling-down-hill strategy is reminiscent of 1217: Cells in that it solves the immediate problem (whether being stuck on a mountain, or having some disease) while also likely killing the patient. It may therefore be in reference to Trump's widely reported comments that an

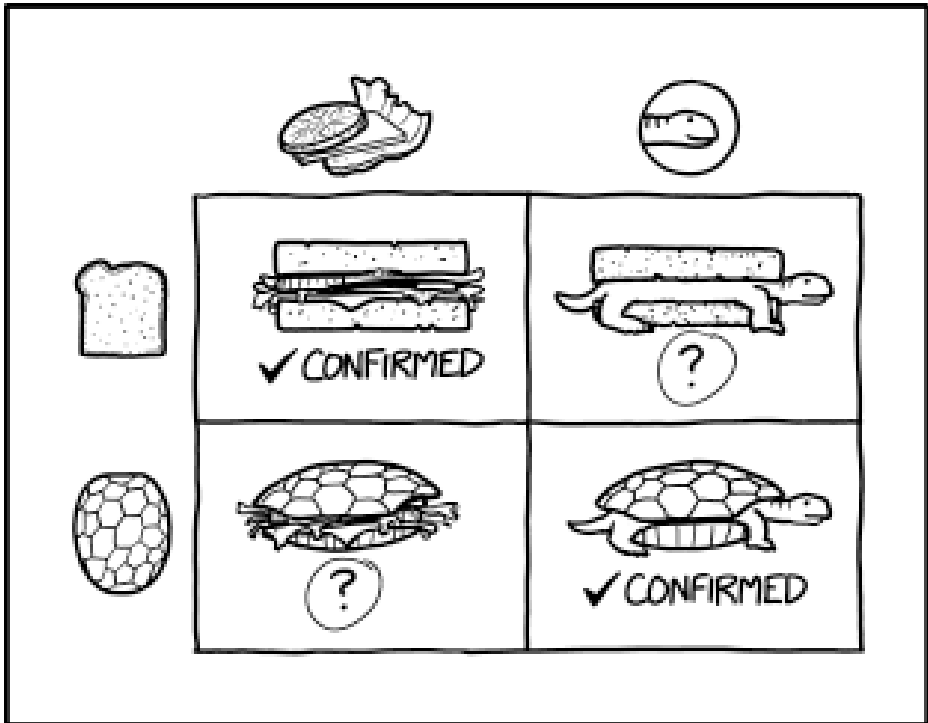
injection of a disinfectant could cure coronavirus; such an injection would "kill" (inactivate) any virus particles it contacted, but it would also kill so many of the patient's cells as to risk the patient's life.

The Cooper's Hill Cheese-Rolling and Wake is an annual event in which people intentionally roll down a steep hill (chasing after a wheel of cheese, or a foam replica since 2013), and they do indeed reach the bottom very quickly (the cheese was known to reach speeds in excess of 70 mph) and are often injured enough to require hospitalization, although because all participants are volunteers in good health, there have been no fatalities. The May 2020 event has been canceled due to COVID-19.

Alternately, it may be a reference to the "just succumb to the problem" solution of ignoring the dangers involved in letting what happens happen. Just quickly get everyone into the valley bottom and they all (who survive) subsequently have a herd immunity where none of them now needs to be scared of falling any more, and can jostle against anyone else without any such issues.

## #2301: Turtle Sandwich Standard Model

May 01, 2020



OUR LAB IS WORKING TO DETECT  
THE TWO MISSING PIECES OF THE  
TURTLE-SANDWICH STANDARD MODEL.

It's possible the bread and shell can be split into a top and bottom flavor, and some models additionally suggest Strange Bread and Charm Shells.

## Explanation

This comic references particle physics. The Standard Model of physics explains the base particles and fields that make up the universe. The elementary fermions of the standard model can be laid out in a  $3 \times 4$  grid, with three "generations" of matter, each containing a quark with charge  $+\frac{2}{3}$ , a quark with charge  $-\frac{1}{3}$ , a lepton with charge  $-1$ , and a neutrino with charge  $0$ . The first generation contains the familiar up and down quarks, which make protons and neutrons, the electron, and the electron neutrino. Each succeeding generation of matter is more massive than the one before, and only the first generation of particles occurs naturally on Earth; the others have only been created and identified in particle accelerator experiments (although they also arguably exist in various extreme places around the universe; for example, the strange quark is suspected to be a component of the denser parts of neutron stars).

Quarks were initially proposed by Murray Gell-Mann to simplify the "particle zoo" that physicists were discovering. He found that the twenty-five or so mesons and hadrons that were known at that time could be organized into what he called the "eightfold way" by just three properties: spin, charge, and what he called "strangeness". He proposed that three quarks (and their corresponding antiquarks) governed these properties. His chart had an empty space for what he called the omega baryon, and when a particle of the properties he predicted (including its mass) was discovered, his model

received a lot of support. The quark model was eventually extended to include six quarks, and as with the eightfold way, one of the lines of evidence in favor of what became known as the Standard Model is that it predicted the existence and masses of several particles, which have since been confirmed; the top quark's mass was predicted in 1973, and experimentally verified in 1995, for example, and on the gauge boson side of the chart, the Higgs boson was discovered in 2012.

In this comic strip, sandwiches (lettuce, cheese, tomato, and possibly other fillings, surrounded by bread) and turtles (an aquatic reptile which wears an armored shell) are likewise proposed to not be "elementary" entities, but in fact combinations of 4 elementary parts, namely bread, fillings, reptile, and shell. The narrator's lab is looking for the hypothesized "bread-shelled turtle" and "shell-coated sandwich". In fiction, turtles' shells are often depicted as articles of clothing which they can remove at will, but in the real world, the shell is a part of the turtle's skeleton, so unless the narrator's lab is willing to commit extremely invasive surgery, they will never find a bread-shelled turtle, although they could much more easily take the shell of a dead turtle and put some sandwich fillings inside.

The failure to detect the bread-shelled turtle could be taken as evidence that the turtle-sandwich standard model is flawed -- perhaps turtles and sandwiches are elementary entities, or perhaps the elementary entities that make them are much smaller than is proposed here. There is also the small matter that there are things besides



sandwiches and turtles in the universe.[citation needed] Alternatively, it could be taken as evidence that the bread-shelled turtle has an extremely high energy, and so does not exist under typical conditions of our universe. This might be analogous to magnetic monopoles; we would know one if and when we saw one (and many experiments have sought them out), and we believe we know how they would behave, but no such particle has ever been verifiably detected or created.

In the same vein, the lack of observation could be due to the instability of the arrangements. Turtleshell-turtle assemblies can last for more than 100 years, while bread-filling assemblies are indefinitely stable under sufficiently low energies. The two other arrangements may simply be formed rarely, and have a relatively short half-life.

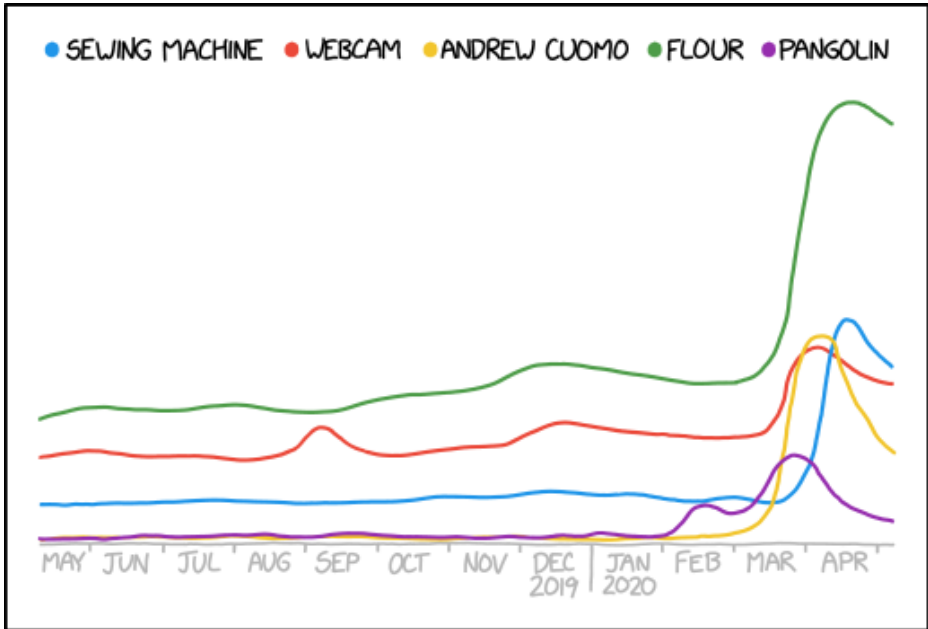
The title text introduces more particle physics jargon, proposing that the "top and bottom" parts of the bread and/or shell have distinct "flavors", and that there may be "strange" and "charm" variants as well (a reference to the higher-generation quarks -- strange and charm in the second generation, and top and bottom in the third).

Unlike the turtle-sandwich standard model, there are no particles predicted by our Standard Model that have not yet been detected; however, there are several gaps between the pure Standard Model and what we observe in reality, most notably the existence of gravity and the apparent asymmetry between the amounts of matter and antimatter in the universe. For this reason, the Standard

Model is generally considered to be somehow incomplete.

## #2302: 2020 Google Trends

May 04, 2020



I WANT TO SHOW SOMEONE FROM 2019 THIS GOOGLE TRENDS GRAPH AND WATCH THEM TRY TO GUESS WHAT HAPPENED IN 2020.

As the 'exotic animals in homemade aprons hosting baking shows' YouTube craze reached its peak in March 2020, Andrew Cuomo announced he was replacing the Statue of Liberty with a bronze pangolin in a chef's hat.

## Explanation

This comic is another comic in a series of comics related to the COVID-19 pandemic.

Randall wants to go back in time to show a 2019 person a Google Trends graph, showing massive spikes in a group of search terms, all around the same time. Some of the terms (flour, webcam, sewing machine) had fairly steady popularity, then rapidly jumped higher. Others (pangolin, Andrew Cuomo) were barely searched for at all until they suddenly became items of intense interest. The joke is that, without context, it would be impossible to guess what caused these simultaneous spikes, and the pattern would seem completely random. A person might guess that there was a single event that drove all of these searches, but it would be difficult to speculate what that might be.

All of these trends are presumably due to the COVID-19 pandemic.

- Searches for "sewing machine" are likely driven by people trying to make their own cloth face masks, to help contain the spread of the virus, due to an ongoing shortage of professionally made masks. (Ironically, a common search is "how to make mask without sewing machine", so this may be partially driven by a lack of machines).
- Searches for "Webcam" are likely driven by a massive increase in virtual meetings and video conferencing, as

people increasingly work from home and pursue other social distancing strategies.

- "Andrew Cuomo" was the governor of New York, the state hit hardest by the pandemic in the United States at the time of this comic's publication. He accrued lots of media attention for his (initially praised, but now rather controversial) response to COVID-19. Governor Cuomo (like most state governors) wasn't subject to much national attention before the epidemic, but became something of a household name during the crisis.
- Searches for "flour" are likely caused by an increase in baking due to people staying at home. This is also referred to in 2296: Sourdough Starter. The searches may be driven by people looking for recipes and baking tips, and it may also be driven by people trying to find flour in the face of local shortages. The little lump at the end of November and December can probably be attributed to people baking for Thanksgiving and Christmas.
- A "pangolin" is a mammal found in Africa and Asia. Pangolins are traditionally little known outside of their natural habitats, with many people in other countries not even aware of their existence (hence the almost total absence of searches at the beginning of the chart). This changed, when it was speculated that SARS-CoV-2 possibly crossed over to humans from wild animals sold in wet markets in Wuhan, China, and pangolins are considered to be one of the most likely sources. This has given the previously obscure creatures a fairly morbid

form of global fame and attention.

The title text is a possible "guess" by the 2019 person for these search terms having an increase together: a YouTube craze of exotic animals (which includes pangolins) in homemade aprons (possibly made with the help of sewing machines) hosting baking shows which leads to a response by New York governor Andrew Cuomo. This is not correct.[citation needed]

A recent prior comic that touches on the past's possible views on the present situation from limited information was 2280: 2010 and 2020. In that case, the relative costs of cryptocurrency and hygiene supplies was considered unremarkable by a 2010 person because (unbeknownst to him) the price of both had skyrocketed.

## #2303: Error Types

*May 06, 2020*

TYPE I ERROR: FALSE POSITIVE

TYPE II ERROR: FALSE NEGATIVE

TYPE III ERROR: TRUE POSITIVE FOR  
INCORRECT REASONS

TYPE IV ERROR: TRUE NEGATIVE FOR  
INCORRECT REASONS

TYPE V ERROR: INCORRECT RESULT WHICH  
LEADS YOU TO A CORRECT  
CONCLUSION DUE TO  
UNRELATED ERRORS

TYPE VI ERROR: CORRECT RESULT WHICH  
YOU INTERPRET WRONG

TYPE VII ERROR: INCORRECT RESULT WHICH  
PRODUCES A COOL GRAPH

TYPE VIII ERROR: INCORRECT RESULT WHICH  
SPARKS FURTHER RESEARCH  
AND THE DEVELOPMENT OF  
NEW TOOLS WHICH REVEAL  
THE FLAW IN THE ORIGINAL  
RESULT WHILE PRODUCING  
NOVEL CORRECT RESULTS

TYPE IX ERROR: THE RISE OF SKYWALKER

Type III error: Mistaking tally marks for Roman numerals

## Explanation

This comic is another comic in a series of comics related to the 2020 pandemic of the coronavirus SARS-CoV-2, which causes COVID-19.

The comic is inspired by the COVID-19 pandemic, as there is a lot of medical testing for the disease being done, including detection of the virus itself, usually by qPCR, or of antibodies present in people who have had the disease (sometimes unknowingly). The quality of these tests is often mediocre and never perfect, leading to discussion of different types of errors that can occur, including "false positives" (calling presence of the virus/antibodies when they are not really there) or false negatives (failing to see the virus/antibodies which are present).

The comic is riffing on Type I and type II errors, also known as "false positive" and "false negative", respectively. The first two rows of the comic's table are correct definitions for established terms in statistics. Further rows contain suggestions for new terminology.



## #2304: Preprint

May 08, 2020



### BENEFITS OF JUST SAYING "A PDF":

- AVOIDS IMPLICATIONS ABOUT PUBLICATION STATUS
- IMMEDIATELY RAISES QUESTIONS ABOUT AUTHOR(S)
- STILL IMPLIES "THIS DOCUMENT WAS PROBABLY PREPARED BY A PROFESSIONAL, BECAUSE NO NORMAL HUMAN TRYING TO COMMUNICATE IN 2020 WOULD CHOOSE THIS RIDICULOUS FORMAT."

**DOWNSIDES:** Adobe people may periodically email your newsroom to ask you to call it an 'Adobe® PDF document,' but they'll reverse course once they learn how sarcastically you can pronounce the registered

trademark symbol.

## Explanation

This comic is about how media reports non-peer-reviewed research papers. The newscaster depicted is attempting to report breaking news based on information in a study; however, the study in question has not been formally published. This leads to uncertainty on the part of either the newscaster, Blondie, or her scriptwriters as they try to determine how to refer to this study, represented here by alternative introduction lines being scribbled out.

Randall suggests that, instead of explaining that the paper was in preprint, or unpublished or submitted to a preprint server and not peer-reviewed, the newscaster could simply say it was a PDF. PDF (Portable Document Format) is a file format for documents developed by Adobe to be used independent of application software, hardware and operating systems.

Randall proceeds to lists several benefits of using "PDF":

- The use of terms such as "preprint" makes statement about its publication status, which might be based on inaccurate information or even be in the process of changing as the news goes out; in contrast, proclaiming it to be a PDF document is an unambiguously factual statement. Additionally, "preprint", "peer review" and related terminology are not familiar to most people who are not academics.
- Referring to the PDF document directly also prevents

individuals from making assumptions that the one responsible knows and has verified what they're doing - or, in contrast, that the information is automatically false based on the grounds that it hasn't yet been officially published.

- The comic finishes with a jab at PDF itself, proclaiming that no ordinary person would voluntarily choose a PDF file as their medium of communication. Ordinary people use the default file format of whatever word processor or text editor they use, but PDF files are not very convenient to edit, so they're generally only used for final versions of documents that are ready to print or distribute, following a dedicated export or conversion process.

This is similar to Randall's declaration in the comic 1301: File Extensions that ".pdf" is the second-most-trustworthy file extension. As it happens, he says that the most trustworthy file extension is ".tex", so perhaps the news anchor could specify that the PDF was "compiled from LaTeX" (if this is true) to imply additional legitimacy.

The title text makes fun of what is incorrectly believed to be the official name of PDF; it is now an open international standard (ISO 32000-1), and the only PDF files that are "Adobe Acrobat files" or "Adobe PDF" files are those created using Adobe Systems' software. Further, Adobe does not use the ® designation in conjunction with PDF. (See Adobe Trademark Guidelines, 1 Nov. 2014) Adobe trademark guidelines

were also made fun of here.

Since so many applications can create and even edit PDF files, implying a connection with Adobe every time someone talks about one is preposterous, and one could sarcastically pronounce the registered trademark symbol to show contempt for the fact that it is a registered trademark.

This comic was possibly produced in response to the preprint study "COVID-19 Antibody Seroprevalence in Santa Clara County, California", Bendavid et al, which was posted online in mid-April 2020 before peer review. The authors of the paper went on a media blitz immediately after posting it, appearing on major cable news networks and writing editorials in major publications, claiming that their results show that COVID-19 is not nearly as bad as thought and that most people are already immune to it. Other scientists have pointed out that, if the very high false-positive rate of the test used and the sample bias of their methodology (testing only people who self-report as sick) are properly considered in the analysis, the data collected is such poor quality as to be meaningless, with properly applied error bars on the number of actual cases in the general population extending below 0. Nonetheless, many less-scientifically-literate politicians, media figures, and protest groups continue to use the much-criticized study as proof that COVID-19 should not be considered an emergency, and that quarantine measures should be cancelled. As of May 11 2020, the study has still not passed peer review, nor undergone any revisions since the

first posting.

## #2305: Coronavirus Polling

May 11, 2020

IT'S HARD TO GET PEOPLE TO AGREE ON *ANYTHING* IN POLLS.

BUT WE AGREE ABOUT THE CORONAVIRUS.

HERE'S HOW AMERICANS FEEL ABOUT COVID-19, ALONG WITH OTHER TOPICS THAT GET SIMILAR LEVELS OF AGREEMENT FOR COMPARISON.

COMPILED WITH HELP FROM HUFFPOST POLLING EDITOR  
ARIEL EDWARDS-LEVY. SOURCES: XKCD.COM/2305/SOURCES

### RECENT CORONAVIRUS POLLS

- 86% SAY "STAY-AT-HOME ORDERS ARE RESPONSIBLE GOVERNMENT POLICIES THAT ARE SAVING LIVES" RATHER THAN "AN OVER-REACTION" (ABC/IPSOS)
- 85% OPPOSE REOPENING SCHOOLS (NPR/MARIST)
- 91% OPPOSE RESUMING BIG SPORTING EVENTS (NPR/M)
- 85% TRUST LOCAL HEALTH OFFICIALS AND HEALTH CARE WORKERS (AXIOS/IPSOS)
- 93% ARE TRYING TO MAINTAIN 6-FOOT DISTANCES WHILE IN PUBLIC (AXIOS/IPSOS)
- 81% SAY AMERICANS SHOULD CONTINUE TO SOCIAL DISTANCE FOR AS LONG AS IS NEEDED TO STOP THE CORONAVIRUS EVEN IF IT MEANS CONTINUED DAMAGE TO THE ECONOMY (POLITICO/MORNING CONSULT)

### OTHER POLLS

- 81% ENJOY APPLE PIE (HUFFPOST/YOUGOV)
- 76% FEEL POSITIVELY ABOUT KITTENS (HUFFPOST/YOUGOV)
- 84% HAVE A FAVORABLE IMPRESSION OF TOM HANKS (IPSOS 2018)
- 89% SAY FAIR ELECTIONS ARE IMPORTANT TO DEMOCRACY (PEW)
- 86% FEEL POSITIVELY TOWARD BETTY WHITE (IPSOS 2011)
- 86% DO NOT TRUST KIM JONG-UN TO DO THE RIGHT THING (PEW 2019)
- 64% ARE CONCERNED ABOUT THE EMERGENCE OF "MURDER HORNETS" (YOUGOV)

If you want to see the polling questions we agree on **MOST**, you can check out Chapter 24 of my book *How To*, where I got the Roper Center on Public Opinion Research to help me design the world's least electable political campaign platform.

## Explanation

This comic is another comic in a series of comics related to the COVID-19 pandemic.

The comic compares opinion polling of COVID-19 related topics to polling of other, mostly unrelated topics. The American public often tends to be sharply divided about major political and social issues, but polling shows that the country is remarkably united about the dangers posed by the COVID-19 and the measures necessary to prevent its spread. This is notable, because responses to this pandemic have significant political and economic implications, which usually results in major division and distrust. The poll results also contradict the extensive news coverage of notable anti-lockdown protests prominent in many major cities; by implication, this comic is arguing that such protests are unrepresentative and disproportionately covered. Or else that this vocal and demonstrative minority is almost the only group making their opinion public in such a newsworthy manner.

To put these majority opinions in perspective, polls on other topics are shown with similar but slightly smaller high percentages of likemindedness but on extremely uncontroversial questions[citation needed] such as liking apple pie or Tom Hanks, or the importance of elections to democracy.

The title text refers to the chapter "How To Win an

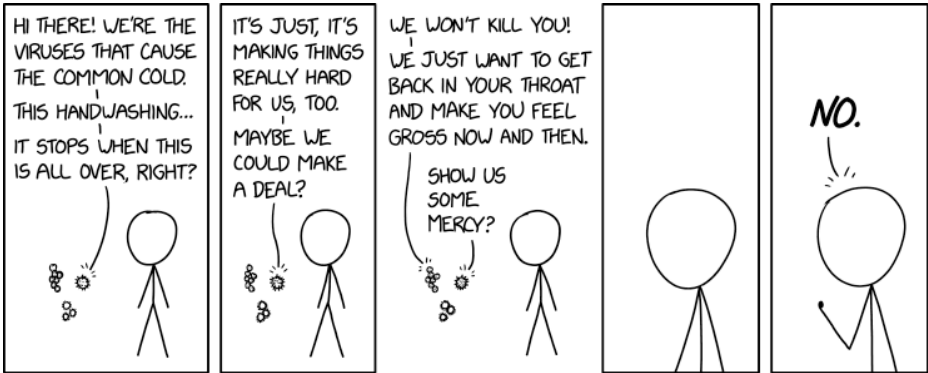


Election" in Munroe's book *How To: Absurd Scientific Advice for Common Real-World Problems*, in which a similar set of near-unanimous survey questions are shown for prospecting candidates to support, or, alternately, oppose, thus guaranteeing their popularity or lack thereof. To see what this politician's speeches might have looked like, we can look at FiveThirtyEight's "perfect stump speeches" that espouse only opinions held by a majority of Republicans or Democrats.

The polls cited in this comic are all linked at <http://xkcd.com/2305/sources>.

## #2306: Common Cold

May 13, 2020



Not even metapneumovirus, easily the common cold virus with the coolest name, warrants our sympathy. Colds suck. No mercy.

## Explanation

This comic is yet another in a series of comics related to the COVID-19 pandemic.

This comic with talking viruses was followed by a comic debating if viruses are Alive Or Not?

Many of the measures humans have undertaken to fight SARS-CoV-2, such as careful hand-washing and sanitizing of frequently-touched surfaces, are effective against most pathogens. Hence, one of the ironic silver linings of the coronavirus pandemic is that the aggressive implementation of these measures is likely to slow the spread, not only of SARS-CoV-2 but of many common illnesses. If these measures become long-term social expectations, they may improve public health long after the current pandemic has passed.

Hand-washing with soap is a particularly effective way to disable coronaviruses and influenza viruses, which have a viral envelope.

Most common colds are caused by a rhinovirus, a non-encapsulated virus that is not as sensitive to soap. Nonetheless, proper and frequent hand-washing appears to reduce the spread of most viruses, by removing biological residue which harbors the virus. Hence, more aggressive hygiene is likely to have at least some impact on most easily transmissible diseases. Handwashing was a major emphasis of anti-COVID measures in mid-2020 when this comic was written, though as more was

learned about the disease (in particular its airborne transmission) the focus shifted more towards masking.

In this strip, Randall addresses the matter from the point of view of viruses. Specifically, those that cause the common cold, imagining them as sentient entities, with spreading infection as their conscious goal. Much like in 2287: Pathogen Resistance, the humor comes from the perspective flip, where health measures intend to protect us are seen by the pathogens as terrifying attacks. In this strip, the cold viruses become aware that more aggressive hygiene measures are putting them at risk, and hope to negotiate with humanity, on the grounds that, unlike SARS-CoV-2, they are rarely fatal. Their hope seems to be that, once the current pandemic is brought under control, humanity will abandon these measures, and allow them to freely spread, once again.

Cueball's adamant refusal likely reflects Randall's hope that this pandemic will result in lasting changes, slowing the spread of all diseases, including those which are merely very unpleasant, as opposed to actually fatal. By treating this as a conscious battle, people may be more inclined to be vigilant, and not allow the enemy any opportunity to recover.

While colds are unlikely to kill otherwise healthy humans, they still cause symptoms that can be painful, even debilitating, in the short term. Previous strips made reference to the miserable nature of the disease. In December 2015, Randall released both 1612: Colds and 1618: Cold Medicine.

The What If? book previously dealt with the plausibility of eliminating the common cold through aggressive physical distancing alone. The section in that book concluded that total elimination would be impractical. However, the current situation suggests that minimizing the spread of disease by careful hygiene measures is realistic.

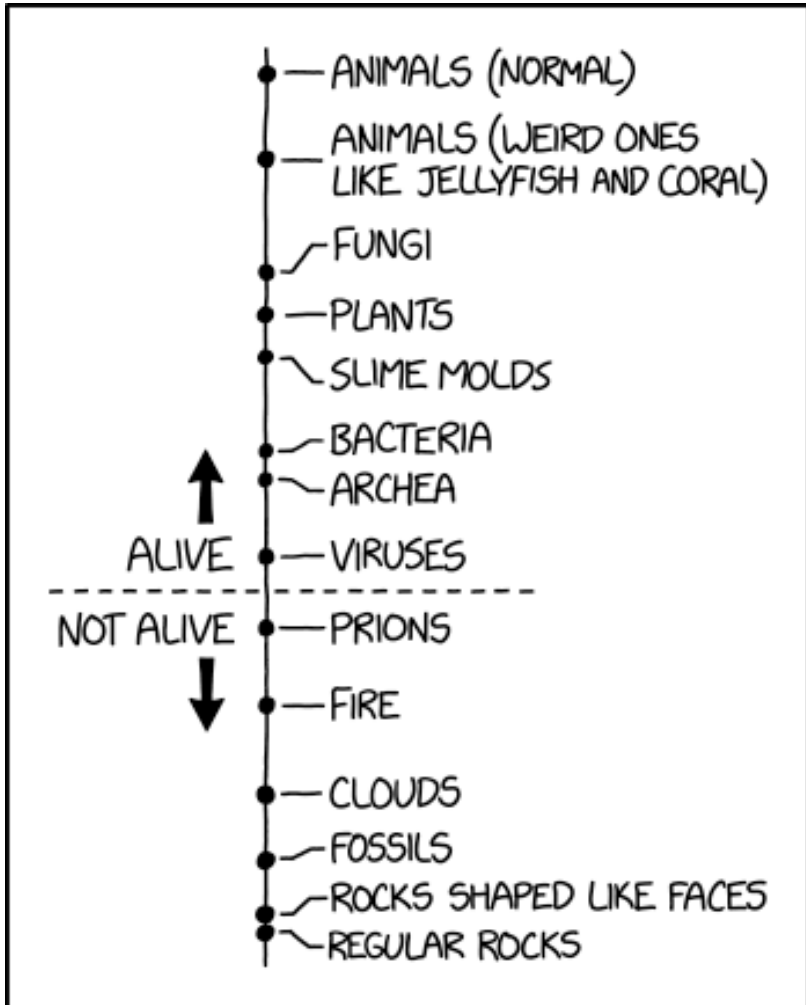
In the title text, Randall mentions a virus with the name metapneumovirus. He states that this is easily the common cold virus with the coolest name. But that does not mean it warrants our sympathy (as it is present in up to 40% of colds, and can be deadly in vulnerable populations). And he finishes by stating that "Colds suck. No mercy." So Randall would not be sorry to see the common cold eliminated, or at least substantially contained, by our coronavirus precautions.

In reality, unfortunately, anti-COVID measures would indeed lapse a few years later, leading to a resurgence of several diseases, including the common cold.

This is at least the second comic featuring pathogens as a characters. The (at least) first was 2287: Pathogen Resistance.

## #2307: Alive or Not

May 15, 2020



Computer viruses currently fall somewhere between prions and fire.

## Explanation

There is no universally-accepted definition of "life"; all definitions thus far proposed have either excluded some things commonly understood to be alive or included some things commonly understood to not be alive. Take reproduction, a trait commonly assumed to be essential and unique to life; by this definition, anything which cannot reproduce (including mules, worker bees, and postmenopausal women) would be considered nonliving, while anything which can duplicate itself (including computer viruses, advanced 3D printers, and fire—see below) would be considered alive.

Many more elaborate definitions of life have been attempted over the decades. Some common additional factors include:

- Homeostasis, the ability to control an internal environment to maintain a constant state;
- Metabolism, converting nutrients into energy and building blocks for growth, reproduction, and so on;
- Adaptation through heredity and natural selection; and
- Responding to the environment.

Despite all of this, the only definite definition of "life" is "something everyone agrees is alive" - and even then, that's also indefinite because of the further ambiguity of what counts as part of "everyone". This comic attempts to rank several types of things by how likely people are to

perceive them as "alive". As there is a debate as to whether viruses are alive or not, Randall has taken a side, and may spark debate, by putting viruses above the alive line.

Given that this comic was released during the early days of the COVID-19 pandemic, viruses are for sure on Randall's mind, given that most comics more than a month before this one was about COVID-19. And this comic is most likely inspired by this, and the previous comic 2306: Common Cold, where the cold viruses are definitely alive, and afraid.

### **Things ranked as alive[edit]**

### **Things ranked as not alive[edit]**

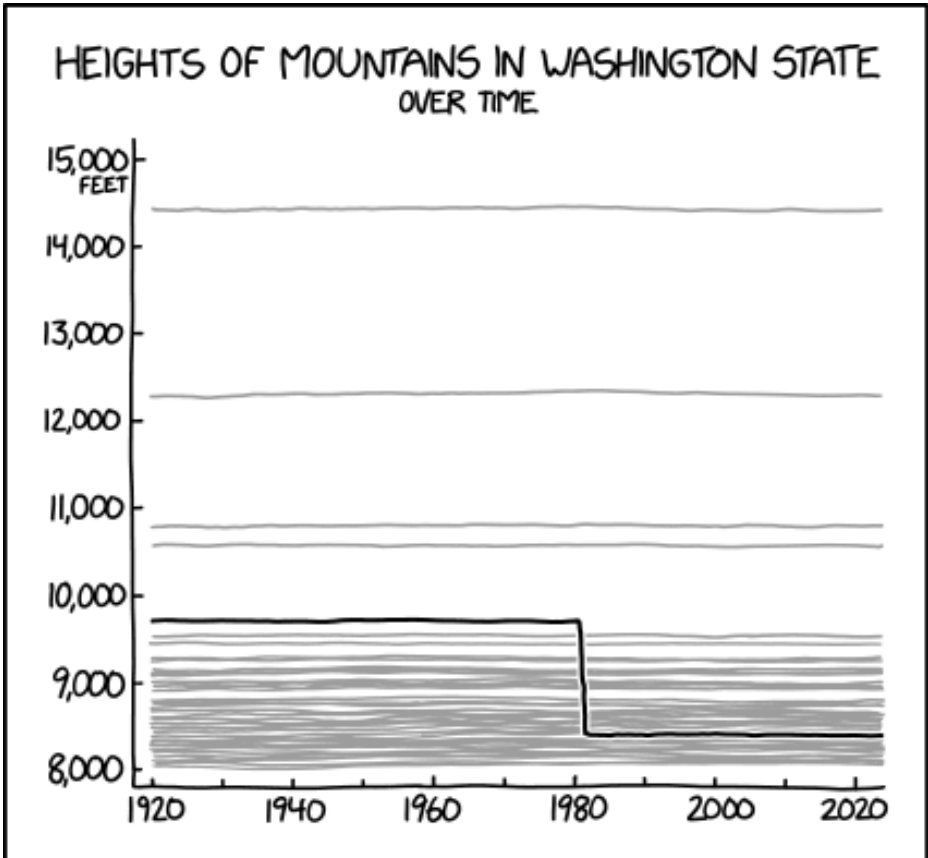
- (from title text) Computer viruses

Interestingly, the vertical line linking the categories extends beyond both the most-alive and least-alive things, making one wonder what Randall might think is more alive than "normal animals" or less alive than "regular rocks". In the latter direction an explanation might be that shortly before this comic the scientific press wrote about heat-resistant bacteria that live in the desert and slowly eat regular rocks generating their own water in this process making even the sand in the desert partially alive.



## #2308: Mount St. Helens

*May 18, 2020*



It's a good mountain but it really peaked in the 80s.

## Explanation

This comic marks the 40 year anniversary of the May 18, 1980 eruption of Mount St. Helens that killed 57 people. It was a Monday so a normal release day could be used to mark this event.

It shows a graph of the height of the mountains in the state of Washington as a function of time over the last 100 years. The only mountain to change its height significantly over this time period is Mount St. Helens, which the comic is named after. It is also the only black line as all other (30?) lines are gray.

Mount St. Helens is a volcano that famously and explosively erupted in 1980. Millions of tons of earth were blasted from one face of the mountain all over the surrounding countryside. After it was over, the peak of Mount St. Helens was no longer the 5th highest in the state of Washington, having lost approximately 1,300 feet (400 m) in height (from 9,677 ft (2,950 m) pre-explosion to 8,363 ft (2,549 m) post-explosion).

The comic shows a rare event that had major effect and was predictable in hindsight, but would have surprised an observer that is just tracking the height of Mt. St. Helens in a non-representative timeframe. Such an event is called a Gray Rhino event.

Currently, the 5 highest mountain peaks in Washington State are Mount Rainier (at 14,411 ft or 4,392 m),

Mount Adams, Mount Baker, Glacier Peak, and Bonanza Peak. As shown in the comic, Mount St. Helens was the 5th highest, but now has fallen to #35 (using a topographic prominence cut-off of 500 m (1640 feet)). Only mountains above 8,000 feet (2,438 m) are included, with the graph topping at 15,000 feet (4,572 m), 600 feet (182 m) above the highest mountain. There are 92 peaks above 8000 feet in the state, so not all are included and the lines are not really distinct below 9000 feet. Seems like there are less than 30 lines drawn. Of course it says Mountains not Mountain peaks, but there are only four mountain ranges in Washington with peaks above 8000, so he must mean peaks!

Technically, the other mountains may be fluctuating in height as well, due to erosion or the movement of Earth's tectonic plates, but this phenomenon should not be visible on the time-scale and vertical resolution that Randall has plotted. Precision GPS measurements of various peaks in Washington have only been available since 2010, and it's likely that the primarily volcanic mountains of Washington experience significant but comparatively slight variations throughout the year due to snowfall, melt, or the pressure of swelling magma inside volcanic cores. These changes go largely unmeasured, while the mountains continue to appear equally physically unchanging and imposing both in person and from a distance.

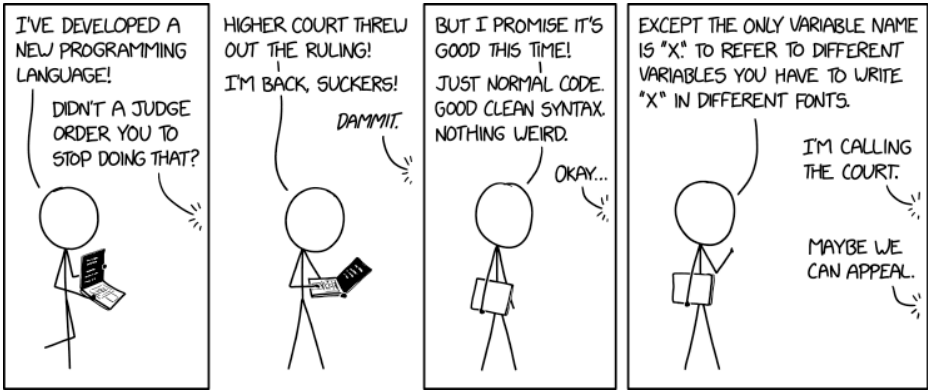
Source: Seattle Times. So while the comic does appear to show some slight fluctuations in height for mountains, that is more likely a side-effect of the comic's free-hand

drawing style than an accurate reflection of any real fluctuations.

The title text is a play on the term "peak" meaning both the highest point of a mountain and also the optimal, most famous or most impressive stage of a trend; for instance: "The band Rolling Stones really peaked in the 80s."

## #2309: X

May 20, 2020



The worst is when you run out of monospaced fonts and have to use variable-width variables.

## Explanation

Cueball has developed a new programming language with novel syntax. Such languages are usually classified as esoteric languages — programming languages developed for no practical use other than novelty, challenge, or academic interest, and which are difficult to understand or work with (although that doesn't stop people from trying to use them). Some classic examples of these are INTERCAL and brainfuck.

This may be a continuation of the Code Quality series – the result, or even the cause, of his known tendency to grossly misuse other more established systems.

Normally, there is no law against developing bad programming languages or bad code (although some would argue there should be). The law often has to play catch-up with technology. However, as when the EPA took an interest in Cueball's Laptop Issues, and Cueball's other tech support problems, it seems that a judge has previously ordered Cueball to stop developing new programming languages, possibly because the result was so egregious as to cause real harm. However, the ruling was overturned on appeal, and Cueball is free to inflict his work on the world once again, unless and until there is another appeal. Cueball's use of the phrase "higher court" suggests that he has not gotten a ruling from the Supreme Court of the United States or whatever state has jurisdiction over him, or else he would have said so, and evidently the offscreen voices hope to appeal to them

and get Cueball's injunction reinstated.

A variable is a piece of data (such as an integer or a string of text) whose value can change over the run of a program. Variables are identified by name and can usually be named any string of alphanumeric characters. To make code easier for a human to follow, variables are usually given a name that indicates what the variable is for; for example, a variable counting how many seconds have passed since the program was launched might be called `elapsedTime`.

The overall concept of a variable is usually first taught in Algebra, where the most basic nondescript name for a variable is `x`. When first learning or teaching programming, it's not unheard of for sample variables in practice problems to be named "`x`". However, outside of a controlled learning environment calling any variable "`x`" is considered bad coding practice, because anyone reading the code will not immediately understand what the variable does unless they are familiar with it. Even the original programmer may come back to it and find that they have forgotten what the variable was for.

Here, Cueball is developing a language where all variables are named `X` - and the only way to differentiate different `Xs` is to write it in different typefaces. Needless to say, this is a terrible idea. The language would be a nightmare to program in, as all of the variables would look very similar unless careful attention is being paid, and there would be little to no way to determine what each one does, since font names are typically not very descriptive.

Additionally, the fact that some fonts look similar (such as Arial and Helvetica) would require the programmer to have an intricate knowledge of different fonts and how to distinguish them from only one letter.

Such a language would also require the source code files to be in some rich text format such as a Word document, in order to store the font information. Additionally, it would also require the use of a word processor or similar in order to edit the code. Programs would also run into difficulties if the system does not have the required fonts installed, or if the font is not licensed for them to use.

By contrast, normal code is always written in plain text (usually with ASCII or UTF-8 encoding), which does not specify a typeface and can be edited by even the most basic of text editors.

This comic may also be a jab at mathematicians, who by convention use variable names which are short and nondescript (e.g. "x"), and which can also be "typeface sensitive" - for example,  $\mathbb{N}$  denotes the set of natural numbers, and it is not uncommon to see the definition of a limit as "For every  $\epsilon > 0$  there exists  $N$  in  $\mathbb{N}$  such that for every  $n$  in  $\mathbb{N}$ , if  $n > N$ ,  $|f(n) - l| < \epsilon$ ". Or for example,  $\operatorname{Re}(z)$  may denote the real part of a complex number, whereas  $\mathbb{R}$  denotes the set of real numbers, and  $R$  might denote the radius of some circle in the complex plane.

The title text references the fact that most code editors use a monospaced font (i.e., one where every character is the same width), as opposed to variable-width fonts, in

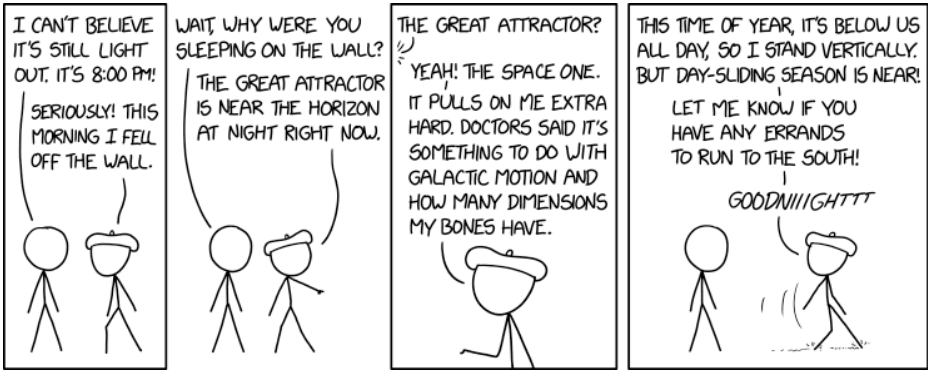


which some characters like 'I' are narrower than others. This is partly because fixed horizontal alignment is sometimes useful when dealing with certain text strings.

'Variable-width variables', a pun on two meanings of the word 'variable', refers to the fact that the letter X, like all letters, has different widths in different fonts. This would make this fixed alignment almost impossible, thus creating yet another reason why Cueball's language would be highly unpleasant to use. It likely also directly (mis)refers to systems such as variable-width encoding in which the data linked to in a variable storage is packed into an unfixed number of bits and/or bytes. Such systems often use Huffman-type encoding to progressively differentiate, from the initial elements, how many more elements are needed to fully define the value, but a reserved delimiting value marking the end of a cumulative arbitrary-length array might be considered another form.

## #2310: Great Attractor

May 22, 2020



Living in the southern hemisphere was nice because I could jump extra high, but I like it here too. Besides, if I ever want to move back, I can just curl up in a ball and wait!

## Explanation

Cueball comments on the fact that as summer approaches, the sun rises earlier and sets later, a common topic of conversation, especially to complain that it is still light at times of day where you are used to it being dark out. Beret Guy comments that he fell off of the wall this morning, a seemingly unconnected topic.

People will often complain about falling out of bed as an indicator of having slept badly. The later sunset is often linked to worsened sleep. However, Beret Guy didn't fall from the bed, he fell from the wall. While being able to figure out he's talking about his worsened sleep, Cueball is understandably confused, so Beret Guy clarifies.

Beret Guy is strongly affected by the Great Attractor, a large gravitational anomaly that influences the galaxies near it, but is difficult to observe directly. Beret Guy claims that the Great Attractor pulls on him unusually hard, which could be another one of his strange powers. This attraction, while not overpowering the gravity of the Earth, (he states in the title text that he can "Jump extra high" when it is above him) affects his life greatly.

For Beret Guy his attraction to the Great Attractor means that, at various times, like now, he can lie on the vertical surface of any wall (external or internal) that is currently oriented in a fortuitous direction (i.e. facing north). He fell off the wall this morning due the Great Attractor being below him during daylight hours and on

the horizon during night hours. Thus, Beret Guy's complaint in the first panel comes across as an attempted solidarity with Cueball's complaint; he was still asleep when the Great Attractor moved to below him, causing him to fall off the wall and presumably awaken him. The Great Attractor reaches the same apparent location once in a stellar day which is about four minutes shorter than the solar day. This means Beret Guy would only be able to sleep on walls for certain part of the year, as the time of day when the Great Attractor is near the horizon would occur 4 minutes earlier each day.

He gives a short explanation of which Attractor he refers to (the space one) and why the Great Attractor affects him. According to his doctors it is apparently caused by the motion of galaxies and how many dimensions his bones have. Since having fewer than 3 spatial dimensions may lead to trouble, his bones may be existing in more dimensions than our normal 3 dimensions of space and 1 of time. Galactic motions normally have no significant effect on a person with 3-D bones.[citation needed]

Beret Guy then says that day-sliding season is near, due to the Great Attractor being at the horizon in the day, and offers to run errands for Cueball in the South, implying that he will be pulled towards the south during day-sliding season, and can run much faster in that direction.

Beret Guy is not standing straight up during this comic, he has one knee slightly bent towards Cueball in the first two panels. This is because it is evening (8:00 PM as

Cueball states) and the Great Attractor is now coming near the horizon, where it will be during the night. So Beret Guy will be pulled towards the south, behind him in the comic, and thus leans away from the pull. In the final panel, when he leaves Cueball, moving right towards south and into the pull, he can be seen sliding along the ground without walking. He leans a bit back to not stumble forward. His last sentence also indicates that he either speeds up or that he is a little uncertain on his feet altering his voice.

He mentions that at the moment during day-time the Great Attractor is beneath him so he can stand straight. He then just feels a little heavier (he will thus weigh more than another person with the same mass).

In the title text he says he liked living in the south because the Great Attractor was often above him, meaning he could jump higher with the help of its pull (and would weigh less than a normal person with same mass). Since he could jump, the force is clearly weaker than Earth's gravity, but still enough for him to easily slide over the ground when it is near the horizon. So he could likely win some high-jump or long-jump competitions if he chose the right time and place.

Being Beret Guy, he is never really unhappy, so he states that he also likes it here (in the north). But then he continues to comment on how easy it will be for him to get to the south. Because if he entirely stopped bracing himself against the pull by crouching into a more spherical shape, and just waited for the Great Attractor

to get near the horizon again, then the pull would cause him to start rolling over the ground to some place with lower net gravitational potential, i.e. further south, where the Great Attractor will be more directly over his head. In practice traveling any extended distance, let alone thousands of kilometers, by rolling would likely result in unpleasant bruising and be generally a bad idea.[citation needed]

A prior example of an xkcd character with alternate gravitational susceptibility is 417: The Man Who Fell Sideways, where a consistent off-vertical pull somehow applies (rather than one linked to a spot on the stellar sphere). In 1376: Jump Cueball floats sideways across the ground a bit above Earth, in a similar idea to being pulled sideways.

See also these other fictional examples of 'personalized' gravitational susceptibilities.

Beret Guy has previously been interested in strange attracting forces in the universe, in 502: Dark Flow, where he hoped it was his mom and wished she would pull on him. It was though not about the Great Attractor, and the force did not clearly affect him, although his love for his mom did affect two space probes, as mentioned in the title text.

This comic came out just a bit more than a month before the next comic with one of Beret Guy's strange powers, 2325: Endorheic Basin. Which is interesting since the previous comic with such a power came back in

November 2017, 1922: Interferometry, more than 2.5 years before this one. Also in the Endorheic Basin comic strange forces exerted a pull on Beret Guy, although in that it was he who attracted water, where here it was himself that was most affected.

Some of the humor of the comic has to do with the immense differences in scale between Beret Guy and the Great Attractor.

In very round numbers our own Milky Way galaxy is 150,000 - 200,000 light years across. It is just one of several galaxies in something called the Local Group, which is around 10,000,000 light years across. And the Local Group is itself in something called the Local Supercluster (also called the Virgo Supercluster), around 110,000,000 light years across. Each galaxy, each group, and each supercluster is not just a chance alignment, but is a gravitational coherent structure. And all this is just yet a part of the even larger Laniakea Supercluster in which also the Great Attractor is located, along with more than 100,000 other galaxies, in a region of space spanning more than 500 million light years.

Something unpredictable (hence "anomalous") is going on with the galaxies in the Local Supercluster (including our own). These galaxies are indeed accelerating away from one another as seen by their red shift. Hubble's Law predicts the expansion should be uniformly proportional to their distance from Earth and from one another. But for the Local Supercluster something is restricting the expansion. That something is, as "viewed"

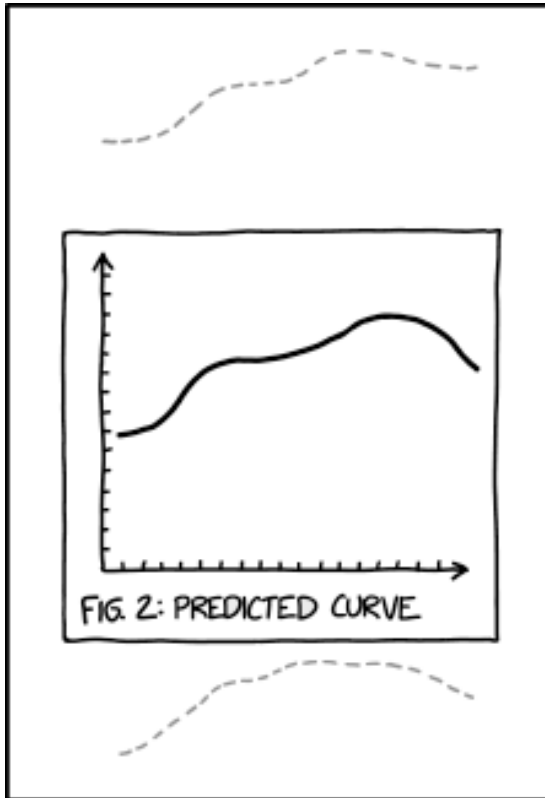
from Earth, somewhere in the direction of the Southern Triangle constellation but 250,000,000 light years distant, and has (but only since 1988) been termed the Great Attractor. The Great Attractor can't conveniently be seen at visible wavelengths, because that direction is the so-called Zone of Avoidance: the area of the night sky obscured by our own Milky Way.

Boiling this all down: something a quarter of a billion light years away that makes an anomalous blip in the local rate of expansion of the universe, and whose existence astronomers deduce only by X-ray observations of stellar red-shift, has large-scale effects on everyday gravitational forces uniquely experienced by Beret Guy. OK, now you can smile.



## #2311: Confidence Interval

May 25, 2020



SCIENCE TIP: IF YOUR MODEL IS  
BAD ENOUGH, THE CONFIDENCE  
INTERVALS WILL FALL OUTSIDE  
THE PRINTABLE AREA.

The worst part is that's the millisigma interval.

## Explanation

This is another one of Randall's Tips, this time a Science Tip. This is the second time that a category of tips (with the first being "Protip") has been re-used.

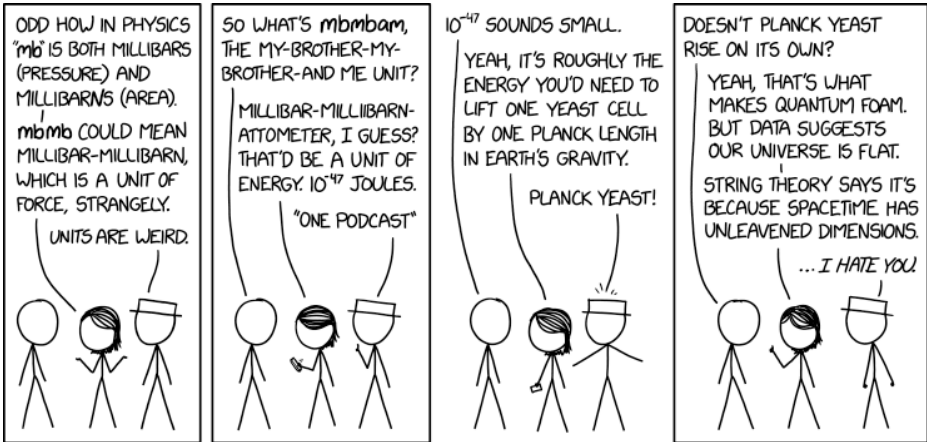
Graphs of continuous functions' predicted values often show confidence intervals, a region (either shaded or marked with dotted lines, the latter used here) that indicates the margin of error for the prediction at any point. The joke in this comic is that the estimate has so much uncertainty that the confidence interval extends off the top and bottom of the chart, which in a real report would usually prevent it from being printed and require a re-scaled chart to show it (if not declined altogether, as data with such wide variance might be deemed useless). This may be a tip as if it's outside the printable area, it won't be seen by anyone who reads it, and thus they won't realize how bad your model is, though this is more of a tip in how to trick people into falsely thinking you've shown a good result with your work than it is a tip in presenting an actual legitimate useful scientific result.

In the title text, a millisigma would be an error of  $\pm 1/1000$ th of a standard deviation. Statistical error and uncertainty is typically measured by standard deviation, which is written in formulas with the Greek letter sigma, and is also frequently referred to by the word "sigma." Measurements of sample means, one of the most common experimentally determined variables, will tend

to follow a normal distribution, such that 68 percent of members of the population will fall within one sigma (plus or minus) of the mean value, 95 percent within two sigma, and 99.7 percent within three sigma. Any of these intervals may be usefully reported as the confidence interval, so long as it's made clear to the reader, but two- or three-sigma are sufficient for most applications. However, this graph shows data of such poor quality (or such poorly-chosen y-axis bounds) that even the millisigma confidence interval (0.08% of the population -- not often used in science, but occasionally found in e.g. molecular analysis tools) does not fit on the graph. Variations in the curve that are small compared to the error bar typically can't be distinguished from errors. Therefore, the shape of the curve - and the entire graph in this example - is meaningless.

## #2312: MBMBaM

May 27, 2020



Hello and welcome to Millibar Millibarn Attometer, an advice show for the Planck era.

## Explanation

In part, this comic is an homage to the referenced podcast, My Brother, My Brother, and Me, which often features rapid garden-path conversations and puns and double entendres that are at once groan-worthy and delightfully witty. "MBMBAM" is an acronym of "My Brother, My Brother, And Me".

The millibar is a metric unit of pressure (force per unit area), equal to a thousandth of a bar, or 100 Pa. It is slightly less than one-thousandth of sea-level atmospheric pressure on Earth (a standard atmosphere is 1013.25 millibar).

The millibarn is a metric unit of area, equal to a thousandth of a barn (a humorously-named unit approximately equal to the cross-sectional area of a uranium nucleus), or  $10^{-31} \text{ m}^2$  or  $10^{-27} \text{ cm}^2$ . Both units would theoretically have the symbol mb. Hence mbmb (the pressure unit multiplied by the area unit) would be a unit of force. This can be seen by applying dimensional analysis; pressure  $\times$  area = (force/area)  $\times$  area = force. Nobody in the comic strip discusses the magnitude of this force, but it would be  $100 \text{ Pa} \times 10^{-31} \text{ m}^2 = 10^{-29} \text{ newtons} = 10^{-24} \text{ dynes}$ , or about the weight of an electron under Earth's gravity.

am would be the symbol of an attometer, or  $10^{-18}$  meters. Multiply that to create the unit mbmbam, which would be a unit of energy. Specifically, it would be a unit

of work: the energy expended to move an object. More dimensional analysis: force  $\times$  distance = (work/distance)  $\times$  distance = work. The actual value of 1 mbmbam is correctly calculated in the comic:  $100 \text{ Pa} \times 10^{-31} \text{ m}^2 \times 10^{-18} \text{ m} = 10^{-47} \text{ joules} = 10^{-40} \text{ erg}$ . White Hat dubs this unit "one podcast".

The final panel is an extended series of puns: 'rise' referring to physically moving upward as well as biologically growing (expanding and becoming lighter and softer) as yeasts do; 'foam' referring to both quantum foam (the fluctuation of spacetime on very small scales due to quantum mechanics) as well as the foam generated by yeast fermenting; 'unleavened dimensions' punning on the eleven dimensions of spacetime in string theory (actually, ten—M theory says eleven), while continuing to play on the theme of yeast—in this case, the universe is presumably flat because some of its dimensions lack the Planck yeast that would make them rise. White Hat appears to have managed to have caught onto these puns, much to his (extreme) dissatisfaction.

The example used in the comic of lifting a yeast cell 1 Planck length is one of many possible examples of 1 mbmbam of work. (The Planck length, approximately  $1.6 \times 10^{-35} \text{ m}$  or  $1.6 \times 10^{-33} \text{ cm}$ , is how far light travels in one unit of Planck time.) Another interpretation of 1 mbmbam would be the work necessary to pull two socially distancing (6 ft) SARS-CoV-2 virions apart by the thickness of a single strand of hair against the gravity they exert on each other.

The Planck Era (or Planck Epoch) referenced in the title text is the near infinitesimally short period covering the first  $10^{-43}$  s after the Big Bang, when energies were so high that the four fundamental forces were combined into one and ordinary subatomic particles didn't yet exist. It is unlikely there were advice shows during this era[citation needed], so this would likely be a modern nostalgia show for physicists. The title text is also a play on My Brother, My Brother and Me's tagline: An advice show for the modren [sic] era.

## #2313: Wrong Times Table

May 29, 2020

### WRONG TIMES TABLE

THE INCORRECT ANSWERS THAT  
FEEL MOST RIGHT TO ME

	1	2	3	4	5	6	7	8	9	10
1	0	$\frac{1}{2}$	4	5	6	7	8	9	10	9
2	$\frac{1}{2}$	8	5	6	12	14	12	18	19	22
3	4	5	10	16	13	12	24	32	21	33
4	5	6	16	32	25	25	29	36	28	48
5	6	12	13	25	50	24	40	45	40	60
6	7	14	12	25	24	32	48	50	72	72
7	8	12	24	29	40	48	42	54	60	84
8	9	18	32	36	45	50	54	48	74	56
9	10	19	21	28	40	72	60	74	72	81
10	9	22	33	48	60	72	84	56	81	110

Deep in some corner of my heart, I suspect that real times tables are wrong about  $6 \times 7 = 42$  and  $8 \times 7 = 56$ .



## Explanation

A "times table" (or multiplication table) is a table used to show the products of numbers. Typically, elementary school children are taught to memorize the table of whole numbers up to 10 as part of learning arithmetic.

In this comic Randall supplies his own alternative version of the multiplication table, with entirely incorrect values that nonetheless "feel" reasonably correct to him. It is unclear how his values are derived, as they don't follow a consistent pattern, but it could be that when calculating products, he sometimes has to correct his mental arithmetic, perhaps thinking along such lines as " $8 \times 4$  is 36... Or, wait, is it 32?". Most of the values are transposed from their correct position (e.g., adding or subtracting one -- or two, or three -- from one or both multiplicands), some are "off by one" (or two, or by a factor of two), and some (mostly in the 1 row and column) could be created by adding, subtracting, or dividing the two factors instead of multiplying them. It is notable that some properties of mathematics are not followed, as sometimes smaller multiplicands multiply to a larger product than larger multiplicands, and sometimes two even multiplicands produce an odd product.

The table is symmetric, indicating that Randall's form of multiplication is commutative.

The title text (referencing Randall's suspicion that

$6 \times 7 = 42$  may be wrong) is an allusion to *The Hitchhiker's Guide to the Galaxy*, in which the ultimate answer to life, the universe, and everything is said to be forty-two. However, in the book this answer is meaningless without knowing the ultimate question, and so to calculate the ultimate question, a planet-sized computer is constructed. This later becomes Earth, but Earth is destroyed shortly before its calculation is complete. Arthur Dent, one of the last surviving humans, has some white mice (pan-dimensional beings looking like white mice to us) try to get him to give them his brain, so they could attempt to recreate the ultimate question, hoping it may be stored within his brain since he was part of the computer matrix up to just before Earth was destroyed a few days before completing a 10 million year calculation. Arthur refuses, and the mice try to think of some question that makes the answer 42 make sense, like "how many roads must a man walk down". They also suggest  $6 \times 7$ . Arthur later tries to recreate the question himself by picking letter tiles from a bag, and produces the sentence "What do you get if you multiply six by nine". This leads him to remark "I always thought something was fundamentally wrong with the universe." Note, however, that operation of said planet-sized computer was disrupted, both by its near-total destruction and by the much earlier crash-landing onto it of the 'B' Ark and its somewhat useless passengers, so it's also possible the universe is okay and only the question was computed incorrectly. As it happens,  $6 \times 9 = 42$  in base 13, but Douglas Adams has disclaimed this as being a mere coincidence. In Randall's table, neither  $6 \times 7$  nor  $6 \times 9$  are

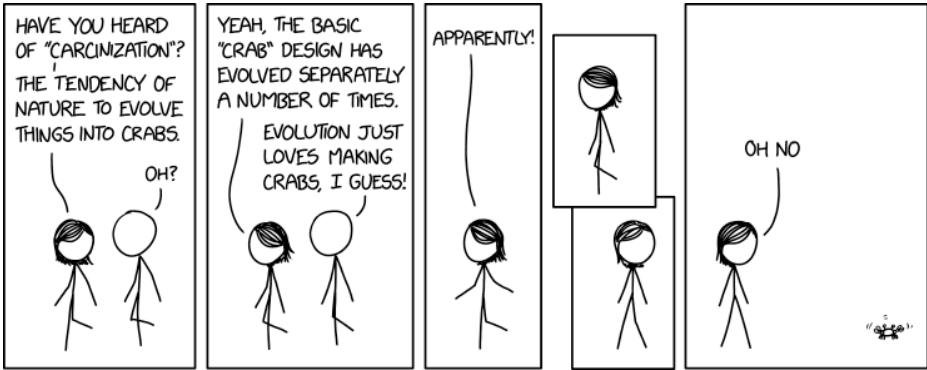
said to result in 42, but  $7 \times 7$  is.

If we consider the smaller multiplicand to be  $a$  and the larger to be  $b$ , then (one of infinitely many possibilities of) the formulas used by Randall are as follows:

The correct multiplication table for the numbers 1-10 is below:

## #2314: Carcinization

June 01, 2020



Nature abhors a vacuum and also anything that's not a crab.

## Explanation

As Megan is telling Cueball, separate species of animals have evolved into "crab-like" forms at different times. Naturalists who noticed the tendency gave it the name carcinization.

It is a specific form of convergent evolution, where differing families of animals (in this case, nominally across the crustacea) develop a tendency towards developing a 'crab' bodyplan to a greater degree than their origins would suggest. A similar process has created several varieties of river dolphin with similar adaptations to their environments, despite being 'stranded' offshoots of different forerunner pelagic species.

"True crabs" (Brachyura) form just a small subset of the Crustacea subphylum, and the Cancer genus is a subset of that, yet there appears to be something about the bodyplan and even resulting behaviour that has meant a number of species have arisen from alternate areas of the family tree that are now trivially indistinguishable without extensive study.

Carl Linnaeus even initially included all Crustacea under the 'Cancer' genus (using the Latin name for crabs), and his taxonomic classification has been heavily refined as further knowledge has come to light, in order to reveal this phenomenon.

Apparently this principle is much stronger in the

webcomic than in real life, as shortly after being told this, Megan notices that Cueball (not a crustacean!) has himself turned into a crab. This isn't really evolution as we know it (outside Pokémon evolution at least), which refers to changes (usually gradual changes, but not always) in a species across generations caused by random mutations. The organisms individually never change[citation needed], they are merely different from their ancestors, and the organisms with changes that make them more fit for their environment are the ones who are more likely to survive long enough to pass down those changes. What happens to Cueball is more like a transformation, but it could still be called 'carcinization', since he becomes crab-like. The comic strip might be an allusion to Franz Kafka's short story *The Metamorphosis* (another word used to describe life-forms that dramatically transform themselves, like caterpillars turning into butterflies), which starts with the main character suddenly waking up and finding that he has transformed into a giant bug.

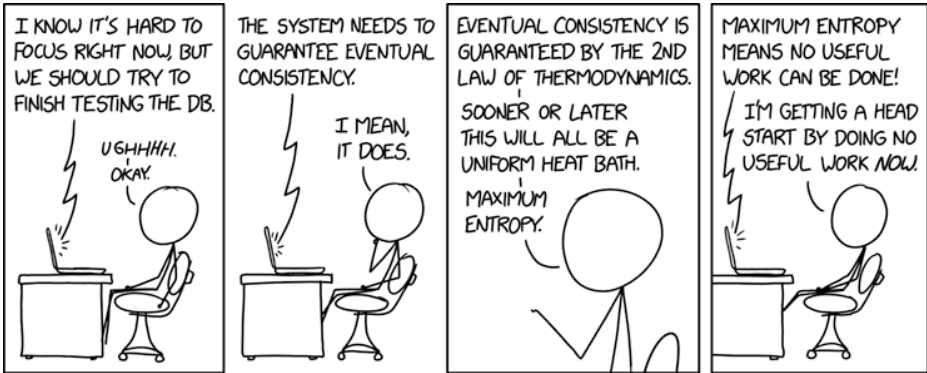
Cueball's sudden transformation is perhaps explained by the title text, that "Nature abhors a vacuum and also anything that's not a crab". The text is a reference to Aristotle's *Horror vacui*, a statement about how empty space tends to be immediately refilled by surrounding things, so vacuums seem to be impossible to maintain. As does "not being a crab", it seems.

Strictly speaking, we don't know for certain that Cueball actually transformed; it could be that he has ducked out of sight and left a crab in his place (or noticed a crab

conveniently nearby) to play a prank on Megan.

## #2315: Eventual Consistency

June 03, 2020



Later I'm going to get a head start on the heat bath.



## Explanation

Cueball's employer wants him to continue his work, possibly as a home-based remote worker as encouraged by the common current advice during the 2020 COVID-19 pandemic.

The stated task is to "test the database" and "guarantee eventual consistency". Trying to avoid work, Cueball points out that the second law of thermodynamics itself "guarantees eventual consistency", as the universe is guaranteed to eventually die a heat death, at maximum entropy and perfect consistency. His boss responds that in a system that has reached maximum entropy, no work can be performed (as this requires a difference in energy states between two sources). Cueball claims that he's simply getting a head start on this.

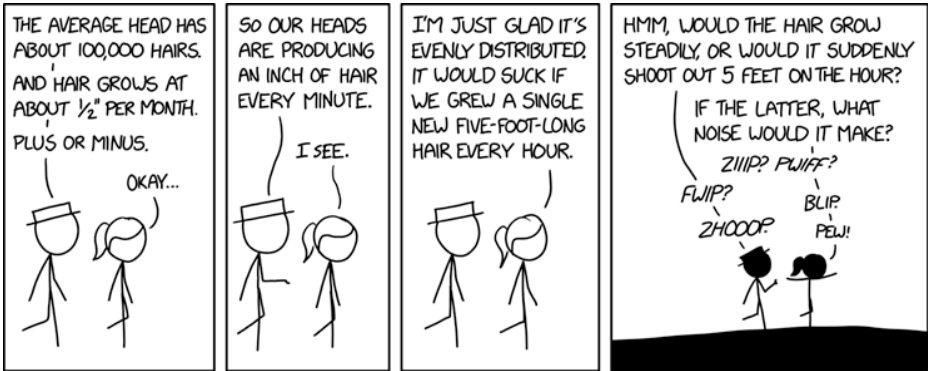
Eventual consistency has a double meaning here. In computing, many systems are distributed (spread out) across multiple servers, sometimes in very different parts of the world. When data changes -- like the number of views on a video or the likes on a social media post -- updating it across every server can be a challenge, and it's often not necessary to keep the data perfectly in sync everywhere. So the system will use eventual consistency instead. Each individual server will record changes, and after a certain amount of time or a certain amount of change, the results will be synced across the whole network. At any given moment, an individual server's data will be a little off -- but eventually everything will get

recorded correctly.

The title text constitutes another play on the words "heat bath", which can refer to the thermally uniform state of the universe at heat death. However, in this context, we can assume Cueball instead plans to prepare a literal warm bath for his own relaxation and enjoyment after or during (or instead of) his work.

## #2316: Hair Growth Rate

June 05, 2020



Hourly haircuts would be annoying, but they'd be easier to do yourself, since you'd have adjacent hairs as a guide. Growing it out would be a huge pain, though.

## Explanation

This strip is one of the simpler jokes that xkcd has done, being an observation on mathematics, biology, and human expectation. White Hat starts by sharing various facts about hair with Ponytail; hair count, individual hair growth rate, and finally total hair growth rate. Ponytail proceeds to snark about how unpleasant it would be if, rather than 100,000 hairs growing at a gross total of five feet (1.524m) per hour, humans grew a single new five-foot-long hair once per hour. The comic then delves into the absurdity of gradual versus spontaneous growth, and then the sound effects involved therein.

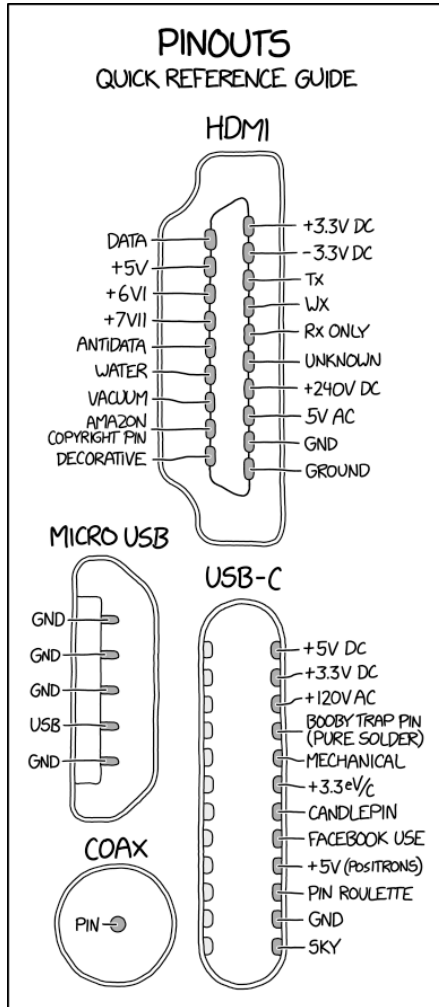
The comic touches on what information can be obscured by just looking at aggregate values. A person whose 100,000 hairs grow a half-inch (1.27cm) per month experiences the same total new hair growth as a person with one hair growing five feet in an hour, but their grooming experiences would be very different. Likewise, a person with one hair growing steadily for an hour has the same average rate of hair growth as a person experiencing sudden hair growth on the hour, but the profile of instantaneous energy conversion and protein production would be very different. One of Ponytail's suggestions for what five feet of instantaneous hair growth might sound like is a sound effect generally used for directed-energy weapons (Pew!).

We never see what sort of hairstyle White Hat has under his hat, but Ponytail's hair is fairly long. If she had to

grow it out by one hair per hour, as in the title text, then it would take over eleven years before all 100,000 hairs had grown out.

## #2317: Pinouts

June 08, 2020



The other side of **USB-C** is rotationally symmetric except that the 3rd pin from the top is designated **FIREWIRE TRIBUTE PIN**.

## Explanation

Electronics connectors are designed to transport both information and power. A pinout diagram describes the function of each pin such as to communicate data, transport power, physical function (keying), etc. In this comic there is an absurd alternative to the actual pins used in connectors. The pin labels are references to many tech issues and attributes, and not all may be documented correctly here.

Hardware hobbyists might feel excitement at seeing a unified specification for these common connectors, but the comic is of course humorous. The real life diagrams are as follows: HDMI, Micro USB, USB-C.

### HDMI[edit]

The HDMI interface uses four pairs of shielded twisted-pair connectors, along with seven other connectors. (Twisted pair means a wire is wrapped with the other wire that returns the current to the original device, thus minimizing electromagnetic noise. Shielding refers to wrapping a cable with a conductor to absorb the energy of noise.) Three of these pairs are for data (TMDS Data0, Data1, and Data2) and the other is a clock. These pairs take up three pins as one of them is a ground pin for the shielding wrapped around each pair. TMDS stands for "Transition-minimized differential signaling" and is also used in the DVI standard.

DDC stands for "Display Data Channel" and is based on the I<sup>2</sup>C serial standard. It is used to allow the transmitting device to learn

what formats of data the receiving device can accept.

CEC stands for "Consumer Electronics Control" and is supposed to allow a single remote control to control multiple devices.

"Hot Plug Detect" refers to hot-plugging, where a cable is connected to a device already turned on. The device should then ideally detect that the cable has been plugged in and respond appropriately.

## **Micro USB[edit]**

A ground pin is commonly found on USB and other pin connectors. At least one ground is necessary to complete the circuit, and some cables use multiple ground lines to distribute current or to support twisted pairs. However, there is no purpose served by having many more ground pins than data pins. Therefore, it seems rather silly for the micro USB to have 4 ground pins and only 1 functional "USB" pin. It also does not give much information about what the "USB" pin would do, as opposed to a standard pinout diagram. This diagram also leaves out the +5V power pin that is present in the real micro USB connector, which would render most USB peripherals unable to function.

The ordering and count of the pins may be an allusion to Monty Python's "Spam" sketch, in which one of the many Spam-related menu items is "Spam, Spam, Spam, egg, and Spam".

## **USB-C[edit]**

The two sides of a USB C connector are labeled "A" and "B". These are rotationally symmetric, mostly. For example, B10 and B11 are Rx1, a separate twisted-pair for receiving information in



Superspeed mode compared to A10 and A11's Rx2. This gives two Rx/Tx pairs for Superspeed use. CC1 and SBU1 are mirrored to CC2 and SBU2. However, the D, VBUS, and GND pins are perfectly mirrored.

The fact that only half of the USB-C pins are documented might hint to an alternative way to manufacture connectors that can be inserted rotated by 180°: Make the receiver use only the right side of the pins and make the sender connect both the left and the right side so all Pins that might match a function are connected correctly no matter if the cable is rotated by 180°. However, doing this would result in only having one Rx/Tx pair for Superspeed use.

## **Coax[edit]**

A coaxial RF connector has two contacts - one pin, and the shield; typically the whole connector is labeled with whatever function/signal is carried by the pair. The joke here is that the label is technically correct (the best kind of correct),[citation needed] but not very useful to the end user, as it does not specify the voltage rating, impedance, connector size, or other useful information about the cable. Some serial data transmission systems, such as Ethernet, used coaxial cable early on as a low cost, widely available solution, however most of these have largely become obsolete. A common coaxial cable still widely in use is RG-6, which is typically used to deliver satellite television, cable television, and cable Internet services in the United States and Canada.

## #2318: Dynamic Entropy

June 10, 2020

### DYNAMIC


"IT'S IMPOSSIBLE TO USE THE WORD 'DYNAMIC' IN THE PEJORATIVE SENSE...THUS, I THOUGHT 'DYNAMIC PROGRAMMING' WAS A GOOD NAME."

- RICHARD BELLMAN, EXPLAINING HOW HE PICKED A NAME FOR HIS MATH RESEARCH TO TRY TO PROTECT IT FROM CRITICISM (EYE OF THE HURRICANE, 1984)

### ENTROPY

"YOU SHOULD CALL IT 'ENTROPY'... NO ONE KNOWS WHAT ENTROPY REALLY IS, SO IN A DEBATE YOU WILL ALWAYS HAVE THE ADVANTAGE."

- JOHN VON NEUMANN, TO CLAUDE SHANNON, ON WHY HE SHOULD BORROW THE PHYSICS TERM IN INFORMATION THEORY (AS TOLD TO MYRON TRIBUS)



**DYNAMIC ENTROPY**

SCIENCE TIP: IF YOU HAVE A COOL CONCEPT YOU NEED A NAME FOR, TRY "DYNAMIC ENTROPY."

Despite years of effort by my physics professors to normalize it, deep down I remain convinced that 'dynamical' is not really a word.

## Explanation

This is another one of Randall's Tips, this time a Science Tip. This time it is a bit special since it came less than three weeks after another Science Tip: 2311: Confidence Interval (which was itself the first time that a non-Protip Tip type has been re-used). This is the first time a type of tip (that was not a Protip) has been used for two "tips comics" in a row.

This Science Tip suggests that if you have a cool new concept, you should call it dynamic entropy.

Dynamic programming is a mathematical optimization method and computer programming method developed by Richard Bellman in the 1950s. The History section of the Wikipedia article contains the full paragraph from Bellman's autobiography that contains the quote that is in the comic strip. Bellman describes how he was doing mathematical research funded by the military at a time when the Secretary of Defense had a literal pathological fear of the word "research", and by extension, "mathematical". Bellman borrowed the word "dynamic" from physics as being both accurate for his work and as a word that in plain English has positive connotations and is never used in a pejorative sense (expressing contempt or disapproval). The word "dynamic" itself comes from the Greek dynamikos, "powerful", which is a positive meaning in itself, and has been applied to topics in physics that are related to motion and forces and used in ordinary English to refer to things that exert power,

force, growth, and change (dynamo, dynamite, and as an adjective). Even though those things aren't always good, when they're bad, we use other words instead (e.g. cancer undergoes metastasis, not "dynamism").

Entropy is a term from physics, specifically statistical mechanics, describing a property of a thermodynamic system. When Claude Shannon developed a mathematical framework for studying signal processing and communications systems, which became known as Information theory, he struggled to come up with a proper name for one mathematical concept in his theory that quantified amount of noise or uncertainty in a signal. Computer scientist John von Neumann noticed the similarity of the equations with some in thermodynamics and suggested, "You should call it entropy, for two reasons. In the first place your uncertainty function has been used in statistical mechanics under that name, so it already has a name. In the second place, and more important, no one really knows what entropy really is, so in a debate you will always have the advantage." (see History of information theory). The following is an excerpt from the explanation of 1862: Particle Properties:

The naming of dynamic programming and of entropy in information theory are both examples of scientists choosing a name for what were at least partially very non-scientific seeming reasons. In one case because it has only positive and no negative connotations in plain English. In the other case because there is much confusion over the meaning of the word so Shannon

would be free to adopt it in a new context. Randall is claiming that would make them great to put together to name some new concept; the combination will mean whatever the creator wants it to mean (even able to change mid-debate), and never sound bad the way that e.g. cold fusion has come to be.

Even though the caption implies that "dynamic entropy" would be available as a new name, it has actually been used in physics, probability, computer science, and even the term "dynamical entropy" in physics and bioscience.

In the title text Randall mentions that, even though his physics professors have continued to use the word "dynamical", "trying to normalize it" by repetitive usage, he remains convinced that it is not really a word. Presumably he doesn't like that it has two suffixes used to make words into adjectives, -ic and -al, as if "dynamic" wasn't already positive enough. The Free Dictionary discusses how -ic and -ical suffixes are confused in many common words and explains their different uses.

The term "dynamical" in physics generally is used in "Dynamical system" or as an adjective to name a concept as applied to dynamical systems such as "dynamical entropy".

## #2319: Large Number Formats

June 12, 2020

### WHAT THE WAY YOU WRITE LARGE NUMBERS SAYS ABOUT YOU

(USING THE APPROXIMATE CURRENT DISTANCE TO JUPITER IN INCHES AS AN EXAMPLE)

25,259,974,097,204

NORMAL PERSON

25 TRILLION

NORMAL PERSON

25 BILLION

OLD BRITISH  
PERSON

$2.526 \times 10^{13}$

SCIENTIST

$2.525997 \times 10^{13}$

SCIENTIST TRYING TO  
AVOID ROUNDING UP

2.526e13 or

$2.526 * 10^{13}$

SOFTWARE DEVELOPER

25,259,973,541,888

SOFTWARE DEVELOPER WHO  
FORGOT ABOUT FLOATS

$10^{13}$

ASTRONOMER

$\{0, \{0\}, \{0, \{0\}\}, \{0, \{0\}, \{ \dots$

SET THEORIST

1,262,998,704,860

SCORE AND FOUR

ABRAHAM LINCOLN

$10^{13.4024}$ : A person who has come back to numbers after a journey deep into some random theoretical field

## Explanation

This comic shows what the way you write large numbers says about you. Different people use different methods to express large numbers. And this comic claims it can tell something about you based on the way you format large numbers. In this way, the comic is similar in idea to 977: Map Projections, where it was your choice of map projections that could tell something about you. See the table below for each of the 10 different ways to express large numbers, plus the 11th mentioned in the title text.

The number used as an example is the approximate distance from the planet Earth to the planet Jupiter as of the release day of the comic on June 12th 2020, in inches (1 inch = 2.54 cm).

Two days after the release of the comic the following text could be found on Jupiter info on The Sky Live.

64,008,410,800,000 cm / 2.54 cm/inches = 25,200,161,732,283 inches - much less than the number used in the comic. But Jupiter's distance to Earth changes quite quickly, and was decreasing at the time of the release of the comic.

According to a graph of the distance as a function of time on The Sky Live, the distance on the release day was 643.1 million km. This will give  $25.3 \times 10^{13}$  which the used number will round to.

The used number 25,259,974,097,204 is equivalent to

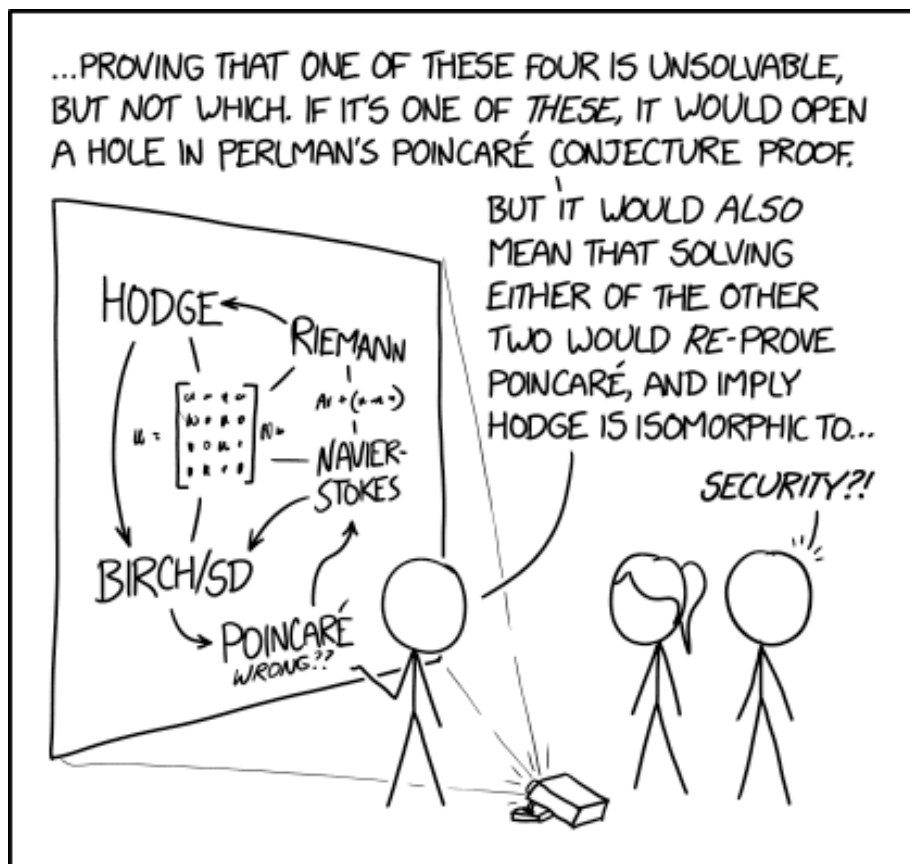
641.6 million km. On June 13th the distance is given as 641.7 million km in the graph on The Sky Live, very close to the number used. As this was the day after the release of this comic, it seems like Randall used a different distance than the exact one for the release day. He may have also used an average for June which would be 642 million km based on the average of the distance on June and July 1st.

**Table of types[edit]**



## #2320: Millennium Problems

June 15, 2020



I'M TRYING TO MAKE IT SO THE CLAY MATHEMATICS INSTITUTE HAS TO OFFER AN EIGHTH PRIZE TO WHOEVER FIGURES OUT WHO THEIR OTHER PRIZES SHOULD GO TO.

The hard part about opening a hole in the proof of the Poincaré conjecture is that Grigori Perelman will come out of retirement to try to fix it by drawing a loop around the hole and contracting it to a point.

## Explanation

Randall, drawn as Cueball, is presenting a slide on the Millennium Prize Problems, seven problems designated by the Clay Mathematics Institute in the year 2000 as some of the most important unsolved problems in mathematics, a sort of successor to David Hilbert's list of 23 problems announced in 1900. The seven problems are:

There are \$1,000,000 prizes attached to each problem, although Grigori Perelman, the mathematician who proved the Poincaré conjecture, turned down his prize, the money instead being used to fund the "Poincaré Chair", a temporary position for young promising mathematicians at the Paris Institut Henri Poincaré.

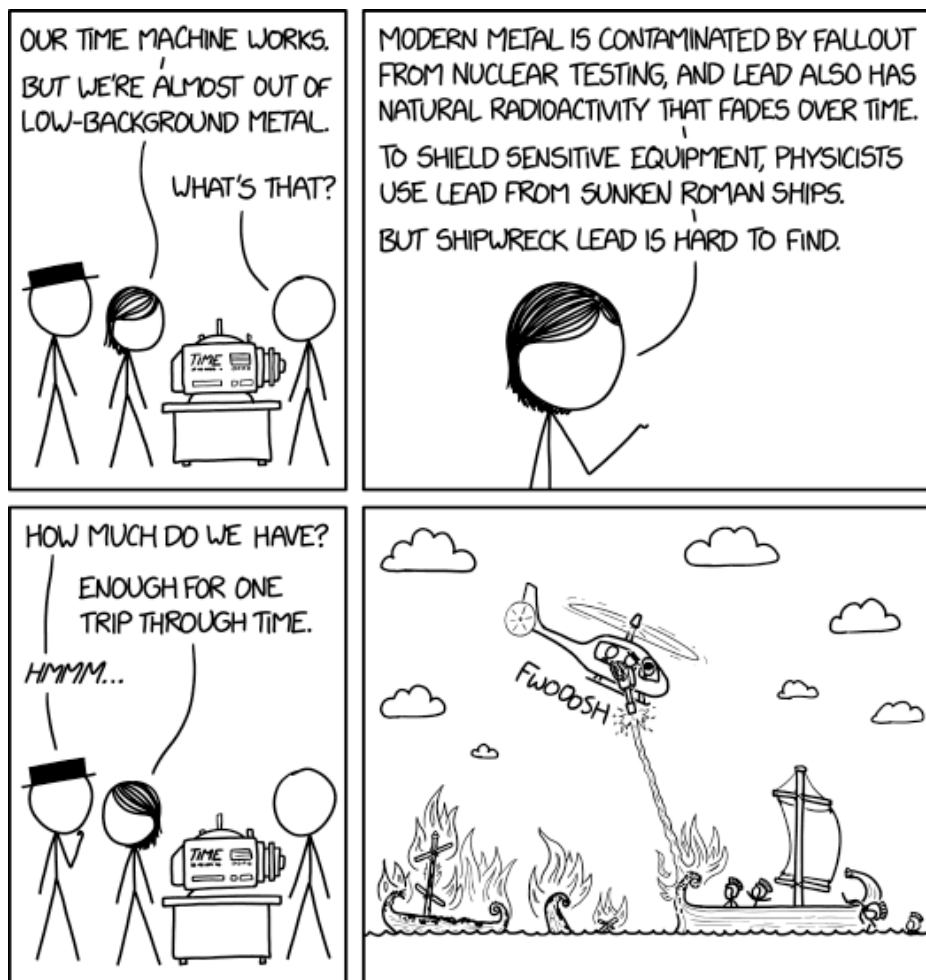
Randall is attempting to demonstrate relationships between the various problems. According to the presentation, proving one might either disprove or prove others, and the proposed interactions between problems are so complex that the Institute might decide to award an additional prize to whoever can figure out which problem or problems have actually been solved by any given proof.

Randall has previously been banned from conferences for various provocative acts; presumably he's on his way to getting thrown out of the Clay Mathematics Institute as well, as the "other" Cueball is already calling security. However, this seems to be only these three people, thus not a conference to be banned from this time.

The title text mentions that, if someone were to find a hole (a common expression for a deficiency or error) in Perelman's proof of the Poincaré conjecture, the famously reclusive author might show up again and fix the problem by applying the theoretical mathematics of differential geometry, where "hole" has a different meaning, to the figurative "hole" in the sequence of logical conclusions. The suggested method of enclosing the hole in a loop and then shrinking it away is reminiscent of the specific technique (Ricci flow with surgery) by which Perelman solved the Poincaré conjecture.

## #2321: Low-Background Metal

June 17, 2020



The only effect on the history books were a few confusing accounts of something called 'Greek fire.'

## Explanation

In this comic, a team including Megan and Black Hat who have invented a time travel machine presents it and their problems to Cueball. Time travel is a common trope in science fiction, and specifically here on xkcd, and such a discovery would be likely to change the world as we know it. However, Megan and Black Hat's machine requires the use of "low-background" metal, which is in short supply.

Megan explains that, while delicate equipment is often shielded from radiation by lead, metal produced in modern times is contaminated by nuclear fallout in the atmosphere, which means that the shielding itself has enough radioactivity to interfere with highly delicate equipment. In order to shield this equipment, "low-background metal" is salvaged from sunken ships. Lead ingots from Roman cargo have been used in experiments. The Roman lead was produced before atmospheric nuclear tests occurred[citation needed] and therefore did not have resulting radionuclides in the air used in its manufacture. When it is extracted, lead is naturally contaminated with the radioactive isotope Pb-210, with a 22 year half-life. Because it has spent many centuries continually underwater, it is both shielded from radioactive particles, and has had time for natural radioactivity to fade.

The number of shipwrecks of that age that can be found and successfully salvaged for metal is quite small, which

puts this material in short supply. Megan mentions that they have only enough for a single trip. The team realizes (apparently at Black Hat's suggestion), that a solution is to use their single trip to take modern military hardware back to the era of the Roman Empire and use it to sink multiple ships. This would both provide for many more shipwrecks to salvage, and give the team a good idea of where those wrecks were, when they returned to modern times. They could also specifically target ships that were in waters that are well-suited for salvage operations.

However, while this might be a pragmatic solution, going back in time to sink ships and murder the occupants doesn't seem like a particularly morally acceptable solution,[citation needed] not to mention opening up potential time travel paradoxes such as what if one of the ship occupants killed was an ancestor to one of the protagonists? If this were a real scenario, there would probably be less drastic solutions available, such as purchasing quantities of lead from the time (would need to convincingly impersonate a local and have something that could be used as currency) and dropping them in the ocean from a (rented) non-destroyed ship, which as a bonus eliminates the need to extract it from the charred remains of a ship later.

Using time travel to retrieve items from the past that are not available in the present is a frequent trope in time travel-related media. Frequently, it is done with the goal of making money, but other purposes are used as well. In the Star Trek movie *The Voyage Home*, time travel is used to retrieve whales and transport them to the present.

In the book *Timeline*, time travel is used to record historical events for entertainment purposes. In the movie *Avengers: Endgame*, time travel is used to retrieve minerals important to a future plan. In the movie *Back to the Future*, when Marty tells Doc that the time machine runs on plutonium, Doc exclaims, "I'm sure that in 1985, plutonium is available at every corner drug store, but in 1955, it's a little hard to come by" (from this transcript).

Low-background steel is the most famous kind of low-background metal, used in real life for highly sensitive particle detectors in physics and medicine, and is salvaged from ships sunk before 1945 (the Trinity nuclear test). Since this is steel, the ships used typically date back to World War I or World War II. (It should be noted that the vast majority of applications that previously required special low-background steel can now once again use ordinary newly-produced steel, as the concentration of radionuclides in the atmosphere has declined almost to pre-1945 levels in the decades since the cessation of atmospheric nuclear testing, due partly to the shorter-lived of these radionuclides having decayed away and partly to processes such as the carbon cycle having removed most of the still-extant radionuclides from the atmosphere.)

The title text refers to Greek fire, which was an incendiary weapon invented and employed by the Byzantine empire. It was a flammable liquid, famously said to burn on water, that was used in naval combat to set fire to enemy ships. As it was a closely-guarded military secret, many of the details have been lost to time,

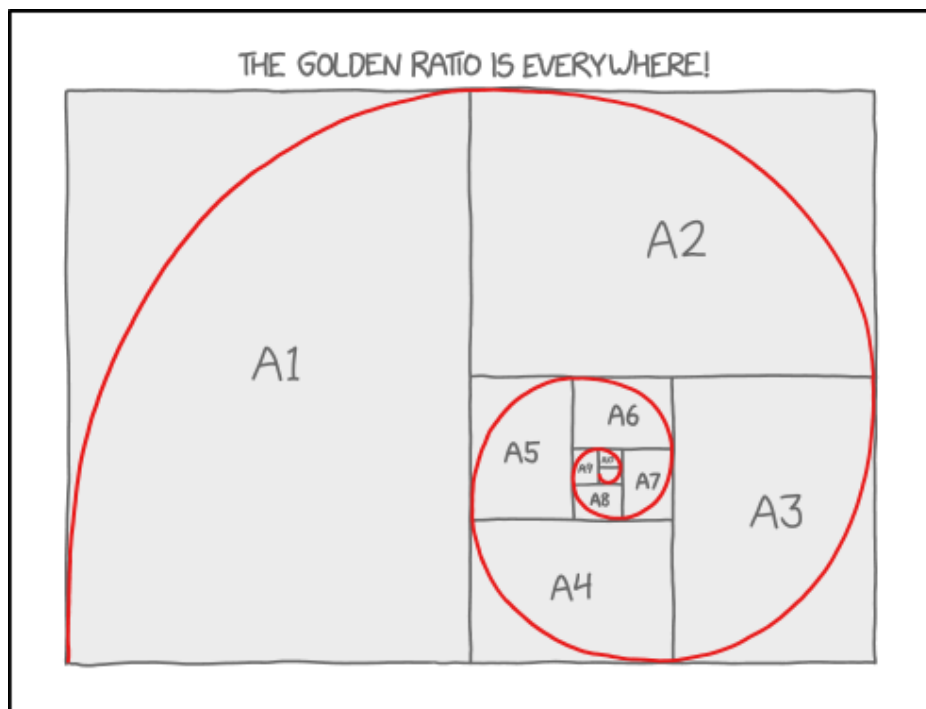
and modern chemists have only been able to develop educated guesses of what it probably was. Randall proposes a rather outlandish alternative hypothesis: that all records of Greek fire were actually in reference to the modern weapons used by the time travelers. It is also notable that, if the time machine was taken to the time of the classical Roman empire, Greek fire would not yet have been a known term. Perhaps the weapon wielded by the time travelers was later conflated with the Byzantines' weapon, or perhaps the time machine was taken to a period a few centuries later than classical Rome.

In 1063: Kill Hitler a single-use time machine is available. It is also used by Black Hat. However, due to the way the time machine in this comic is used, it must be assumed that they can use it again after the salvage of lead from the sunken ships.



## #2322: ISO Paper Size Golden Spiral

June 19, 2020



HOW TO ANNOY BOTH GRAPHIC DESIGNERS AND MATHEMATICIANS

The ISO 216 standard ratio is  $\cos(45^\circ)$ , but American letter paper is  $8.5 \times 11$  because it uses radians, and  $8.5/11 = \pi/4$ .

## Explanation

This is another comic on How to annoy people, here both graphic designers and mathematicians. This type of annoyance seems much like that displayed in 590: Papyrus and 1015: Kerning.

An easy way to annoy many mathematicians is to make fanciful claims about the Golden Ratio. It's been claimed, with varying levels of credibility, to be detectable in many natural and human-made situations, often with the dubious subjective claim that using the ratio in some particular way makes an image more "beautiful". The Golden Spiral is a spiral whose growth factor is this ratio; a common (though slightly geometrically inaccurate) way to illustrate the spiral is to draw curves through a set of squares whose side lengths shrink according to the Golden Ratio. The result looks rather like Randall's drawing here.

However, Randall hasn't used the Golden Ratio at all; he's just drawn a spiral (not the Golden Spiral) through a common diagram showing the A Series of standard paper sizes, but in landscape instead of portrait (this diagram is commonly drawn in portrait). These papers aren't squares at all, but rectangles whose side lengths shrink by a factor of the square root of 2. Additionally, the paper sizes shrink by a factor of one half, so the area is filled in a geometric series. This is sometimes called a silver rectangle, although the Silver ratio is actually  $1+\sqrt{2}$ . By mistaking the A Series for something connected with the

Golden Ratio, and perpetuating the tradition of making dubious claims about the Golden Ratio, Randall has successfully annoyed both graphic designers and mathematicians.

The title text is a similarly themed joke, based partly on the fact that the US uses customary units while the vast majority of the rest of the world uses SI units. The 11/8.5 ratio is the length/width ratio of US Letter paper, which is 11 inches by 8.5 inches (another common size in the United States is US Legal, which is 14" by 8.5"). The value of  $\pi/4$  radians is indeed equal to 45 degrees, although Randall takes the cosine in one case and uses the raw angle in the other case in order to get a close coincidence of values. The width and length of A Series paper (ISO 216) is always given in whole millimeters, and the width/length ratio is very close to  $\cos(45^\circ)$  (which is  $1/\sqrt{2}=0.707\dots$ ) As for US Letter paper: to 4 decimal places,  $8.5/11 = 0.7727$  and  $\pi/4 = 0.7854$ .

In reality, the usage of radians vs. degrees is not a geographic or political decision, but generally is delineated by profession. Most engineering and science fields measure angles in degrees or fractions of degrees (arcseconds, or even milliarcseconds in fields like astronomy), while mathematicians and physicists generally use radians. Civil engineers may refer to the slope of a road by its grade, which is commonly expressed in terms of the tangent of the angle to the horizontal (either as a percentage or a ratio); for angles up to  $\sim 10^\circ$ , this is close to the value of the angle in radians.

The difference between the "real" Golden Spiral squares and Randall's version is approximately either .2038 (for  $\sqrt{2}-1.6180\dots$ ) or .08907 ( $(1/\sqrt{2})-1.6180\dots$ ), depending on which way you're counting. Either way, the difference would be very noticeable.

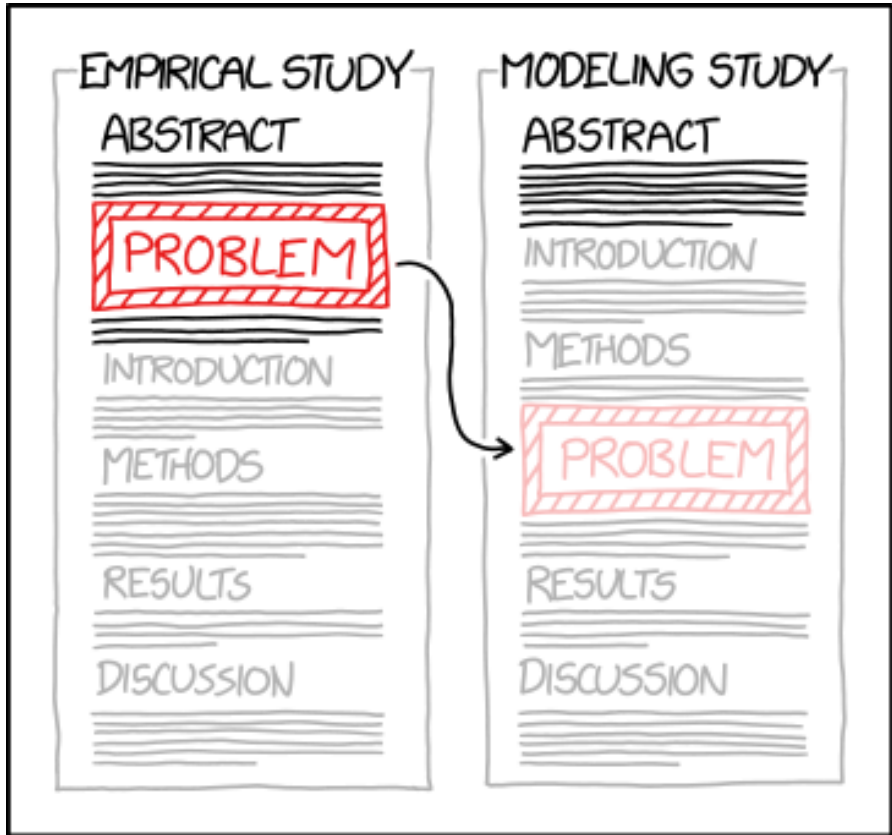
The spiral shown is approximately a logarithmic spiral with a growth factor of  $\sqrt{2}$ , although it has been edited slightly to make it fit neatly inside the rectangles.

If the center of the spiral is at the origin, it may be graphed with  $r = C \cdot 2^{(\theta/\pi)}$ , for any positive constant  $C$ .

In 1488: Flowcharts a golden spiral has been laid in over the chart. That comic is a link that goes to the spiral page on xkcd.

## #2323: Modeling Study

June 22, 2020



A MATHEMATICAL MODEL IS A POWERFUL  
TOOL FOR TAKING HARD PROBLEMS AND  
MOVING THEM TO THE METHODS SECTION.

You've got questions, we've got assumptions.

## Explanation

In this comic, a humorous comparison is drawn between two common types of scientific studies: empirical research, where an experiment is designed to test a scientific theory, and mathematical modeling, where mathematical formulations are produced to predict how physical systems behave under given circumstances. In empirical studies, hard questions about the limitations of existing theory tend to be addressed in the abstract, which is the brief summary of the paper that is presented at the beginning of most scientific articles. In modeling studies, assumptions based on existing theory are built into the model, and any problems associated with these assumptions tend to be discussed in the methods section, which outlines the design of an experiment in the case of an empirical study, or how the model was designed and the reasoning behind the choices made in the case of a modeling study. In the empirical study, the proverbial "big red problem box" is stated up-front where everyone who finds the paper will read it, while in the modeling study, it's buried in the middle of the paper, where it's less likely to be read.

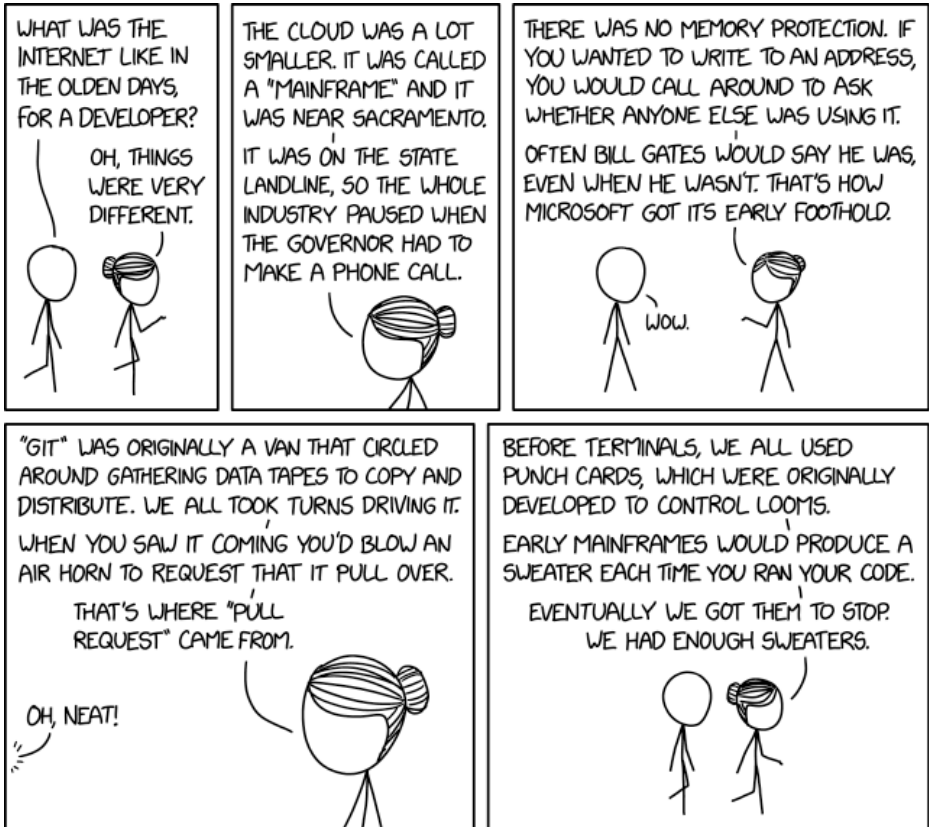
The caption opens like a typical statement in favor of modeling studies, "A mathematical model is a powerful tool for taking hard problems," but while a researcher who works with models might go on to say "...and breaking them down," or "...and studying them in ways that would be impractical for empirical studies," Randall concludes that they can't actually make hard problems

any easier. His title text, "You've got questions, we've got assumptions," plays on the slogan of the now-defunct electronics chain (and former employer of Black Hat) RadioShack of "You've got questions, we've got answers" by pointing out that any answers provided are built on assumptions by the modelers. In other words, garbage in, garbage out.

Randall doesn't call this a "tip", but it does fit in with his science tip in 2311: Confidence Interval, namely, that "If your model is bad enough, the confidence intervals will fall outside the printable area." Much as that tip suggests that a model's results can be made to look more impressive by hiding the error bounds outside the printed area of a graph, this comic strip suggests that acknowledgments of problems can be moved to less-trafficked parts of the paper by switching from empirical to modeling studies.

## #2324: Old Days 2

June 24, 2020



The git vehicle fleet eventually pivoted to selling ice cream, but some holdovers remain. If you flag down an ice cream truck and hand the driver a floppy disk, a few hours later you'll get an invite to a git repo.



## Explanation

In this sequel to 1755: Old Days, which was released more than three and a half years earlier, the conversation continues, as if no time has passed, between (young) Cueball and (old) Hairbun about computer programming in the past. As in the first comic in this series, Cueball, having only a faint idea of just how difficult and byzantine programming was "in the old days", asks Hairbun to enlighten him on the specifics. Hairbun promptly seizes the opportunity to screw with his head.

The new claims:

- The cloud was smaller and called a "Mainframe" and was near Sacramento.

This is a joke on many cloud services replacing mainframes. Both systems were or are used to provide an expansive quantity of computing capability by enabling users to use only some of the available resources, sharing with other users. In those early days, it is true that large mainframes would handle multiple people's jobs at once, using techniques like time-sharing (although they were not necessarily located near Sacramento, the capital of California.). What's more, the basic ideas behind how cloud computing used to go way back. Multics was an early time-sharing system designed to "support a computing utility similar to the telephone and electricity utilities". The idea was similar to the cloud, where

anybody could just hook up and get computing service, as well as other services built into the mainframe. For this reason, many of the computer security concepts we have today - such as kernelized operating systems - come from early systems like Multics.

- It was on the state landline.

In the days of mainframes, remote users often used landlines (i.e. hard-wired telephone connections) to communicate, via dial-up modems, and so users would have to disconnect for making phone calls. Even in the age of all landlines, there was never such a thing as "the state landline", imagined as an immense shared party line to which the governor would have priority access for making calls.

- No memory protection; instead, people would call around to ask whether anyone else using an address and Microsoft's early foothold in computing was because of Bill Gates lying about his usage of addresses.

Memory protection protects storage from access by other programs or users. Many computer systems provide hardware and operating systems to support this. Hairbun is correct in that this sort of code was not well-developed early on. She claims that management of the memory was all done manually by agreement of the developers, and the only way to check if editing a particular address in the Mainframe was safe was physically asking all the other developers if they were already using it. In early PCs it was common to use

specific memory locations, defined by the operating system or the hardware itself, to communicate with the operating system or perform particular functions such as direct graphical memory addressing rather than code compiling to pass through multiple Hardware Abstraction Layers. Her implication is that Bill Gates took advantage of this honor system to restrict people not working for Microsoft from making changes, allowing the company to take ownership of a lot of code - another fib with a grain of truth in it, based on Microsoft's excessive usage of limited standard-mandated pools. For example, out of 256 possible identifiers for partition type shared between all operating systems running on IBM PC compatible hardware, 65 entries are allocated to miscellaneous variants of FAT and NTFS systems, 38 of them originating from Microsoft itself - including esoteric variants like "Corrupted fault-tolerant FAT16B mirrored master volume."

- "Git" was a van that drove around gathering tapes to copy, and the term "pull request" came from the van physically pulling over when signaled with an air horn.

Git is a distributed version control system, which manages copies of a coding project to prevent and resolve conflicts from multiple people editing the project at once. It works by having individual contributors pull the project onto their device, make their changes, and then push those changes back to be integrated into the master copy. The term "pull request" is primarily used after a user has pushed their new code and is requesting that those changes be integrated into the primary codebase,

i.e. that the primary developer would pull those changes into the main branch. Bulk data used to be stored on magnetic tape; in order for version control to exist at this time, there would have to be a master tape that was copied and physically distributed to each contributor, and then the edited tapes would be gathered afterward and conflicts resolved. Hairbun claims that Git provided this service back then using vans. In reality, Git did not exist until 2005, long after digital computers and networked servers became widely accessible and the "early internet" was history. Other systems for providing the same functionality existed for decades before this, with Source Code Control System (SCCS) having been released in 1972. Even this software was implemented primarily for multiple users accessing the same system, rather than users on separate, unconnected ones. Physically carrying storage devices around (sneakernet) has sometimes been used where electronic communication or bandwidth was not available. For example, motorcycle drivers on a regular route, carrying flash drives to remote communities (see delay-tolerant networking). This form of file transfer was also the subject of comic 949: File Transfer.

- Before terminals we all used punch cards, which were originally developed to control looms, and so the Mainframe would produce sweaters when code was run.

Another initial truth going into complete nonsense. It is true that some looms were controlled by punch cards (dating back to 1745), and so were early computer

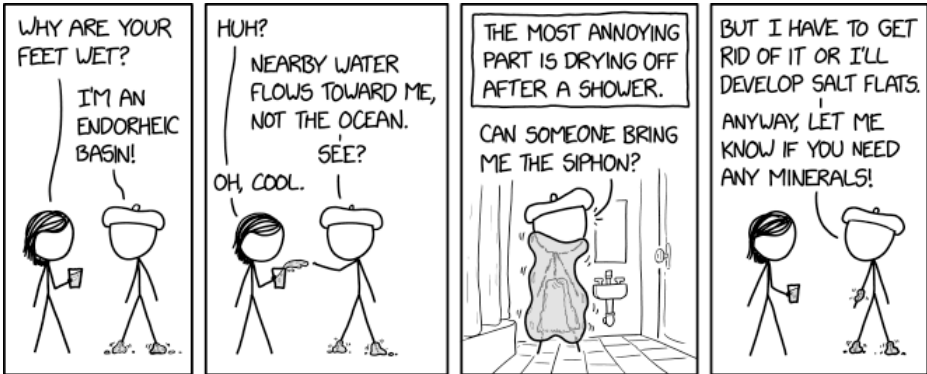
precursors. At the same time Charles Babbage used them around 1830 to control his Analytical Engine. However, Hairbun's statement is that because of this, the same punch card machines would run both simultaneously, such that feeding a set of cards to compile code would necessarily cause a sweater to be produced by the connected loom, which was then sent to the developer. For one: industrial looms don't produce sweaters, but fabrics (which is often patterned if punch cards are involved). And it's not likely that any punch patterns used in computer coding would be interpretable as a suitable pattern for a sweater. However, there is loom knitting which does produce patterns for sweaters.

- (From the title text) You can still hand in a floppy disk to an ice cream truck and get an invite to a git repo a few hours later.

Git repo is short for Git repository, the place where all the files associated with a project are stored. Hairbun tries to convince Cueball that modern ice cream truck drivers service Git in the same way she says the vans did before and that it's still possible to give them a floppy disk (a magnetic storage device) in order to gain access to a repo. The ice cream industry has no connection to computing.[citation needed]

## #2325: Endorheic Basin

June 26, 2020



My biggest fear is that colonial engineers will try to flood me to generate electricity. My biggest hope is that I'll develop sailing stones.

## Explanation

Yet another comic with one of Beret Guy's strange powers. This time he attracts water so it flows to him rather than running out towards the nearby oceans. He thus claims he is an endorheic basin, hence the title.

An endorheic basin is a limited drainage basin that normally retains water and allows no outflow to other external bodies of water, such as rivers or oceans, but converges instead into lakes or swamps, permanent or seasonal, that equilibrate through evaporation. The Caspian Sea in Asia is the largest such basin. It is debated if it is a lake or a sea (it is salty, but not connected to the oceans). If it is a lake then it is the world's largest lake.

Real-life endorheic basins do not attract water in any unusual ways. Rather, they form when low-lying, inland areas receive water from rivers and streams, but not enough to flood them completely and allow the water to overflow into an ocean. As the surface of the lake grows, so do the rate of evaporation and seepage into the ground, until they're equivalent to the inflow of water (at least, on a yearly average). Obviously, Beret Guy's inexplicable effect on water is distinct from the way actual endorheic basins function.

The panel showing Beret Guy after a shower looks similar to what could happen in a space station if you have liquid water in zero gravity. The water in this environment sticks to any surface it encounters.[actual

citation needed] See for instance the start of this video Water in zero gravity and this one Wringing out Water on the ISS - for Science! to see how water reacts to human skin in zero gravity. It is thus almost impossible for him to dry off after a shower. It seems like the water that is attracted to him is still somewhat subject to gravity, as it pools downwards upon him; presumably he knows to finish showering before it floods over his face.

In fact he needs someone to come with a siphon to get rid of the water. A siphon is a hose or u-shaped pipe, where the downward pipe is longer than the upward section. Thus the water falling in the downward section creates a pull lifting the water in the upward section up to the highest point, from which it will flow down pulling more water up. As the endorheic basin caused by Beret Guy seems to have a limited reach, placing one end of the pipe sufficiently far outside creates a similar effect: The water outside Beret Guy's area of effect flows down under the influence of gravity, creating a pull lifting the water near him "up" out of the endorheic basin. Randall made a what if? article about siphons called Europa Water Siphon.

As with real endorheic basins, if the water is allowed to sit, it will eventually evaporate, but he notes that he'll "develop salt flats". Water from rivers carry salts, typically in low concentrations, and if a lake lacks outflows, the salts build up over time, as the water evaporates. If a salt lake evaporates completely, it can create salt flats (or salt pans), like those near Salt Lake City in Utah, e.g. the Bonneville Salt Flats. These salts come in a variety of



forms, including minerals. Sometimes, endorheic basins have high enough concentrations of dissolved minerals to be worth extracting, which is presumably what he means by "let me know if you need any minerals".

There may also be a contrived pun here, in that "flats" is a description of various types of footwear (among them: women's shoes that are not high-heeled and ballet shoes not specifically reinforced for advanced 'pointe' dancing), and the water would clearly leave the 'flats' on his feet.

In the title text, Beret Guy mentions his "biggest fear" due to his water attracting abilities is being flooded to by "colonial engineers" in order for them to use him and the water to generate electricity. This may be a reference to the Qattara Depression Project. The Qattara depression is a low-lying region near the Egyptian coast. For nearly a century, there have been proposals to dig a canal from the sea to flood this depression, deliberately creating a huge endorheic basin. By placing hydroelectric dams along the canal, the proposals hoped to generate huge amounts of electricity. At least one proposal included the use of nuclear explosions to create the canal, which may help to explain why he considers this his biggest fear.

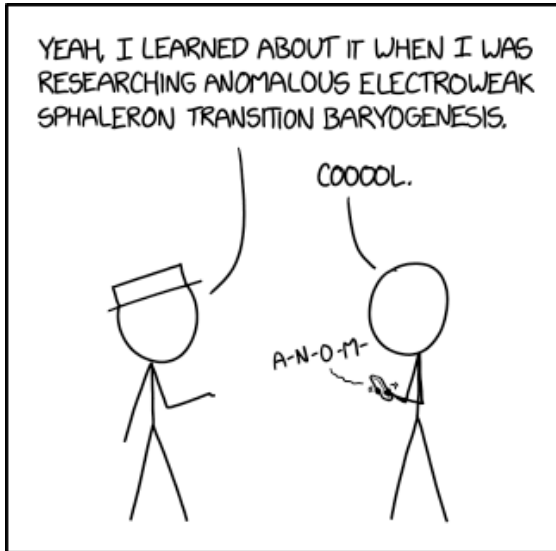
He then mentions that his "biggest hope", due to his ability, is that he will generate sailing stones. Sailing stones (also known as sliding rocks, walking rocks, rolling stones, and moving rocks), are a geological phenomenon where rocks move and inscribe long tracks along a smooth valley floor without human or animal

intervention. The movement of the rocks occurs when large ice sheets a few millimeters thick and floating in an ephemeral winter pond start to break up during sunny days. Frozen during cold winter nights, these thin floating ice panels are driven by wind and shove rocks at speeds up to 5 meters per minute. The Racetrack Playa, an endorheic basin in Death Valley, is one of the most famous locations for sailing stones.

This comic came out just a bit more than a month after the previous comic with one of Beret Guy's strange powers, 2310: Great Attractor, in which strange forces exerted a pull on Beret Guy. It does not appear that he himself is drawn to water, and we cannot determine if the Great Attractor is drawn to him, so Newton's Third Law may be constantly being broken, along with the more obvious scientific impossibilities that surround Beret Guy.

## #2326: Five Word Jargon

June 29, 2020



MY HOBBY: COLLECTING REALLY SATISFYING-SOUNDING FIVE-WORD TECHNICAL PHRASES.

### CURRENT FAVORITES

- TRANSJUGULAR INTRAHEPATIC PORTOSYSTEMIC SHUNT PLACEMENT
- GENERALIZED AUTOREGRESSIVE CONDITIONAL HETEROSKEDASTICITY MODEL
- UNICELLULAR DIAZOTROPHIC CYANOBACTERIA GROUP A
- ANOMALOUS ELECTROWEAK SPHALERON TRANSITION BARYOGENESIS

My other (much harder) hobby is trying to engineer situations where I have an excuse to use more than one of them in short succession.

## Explanation

This is another comic in Randall's My Hobby series, the first of two hobby comics released in the same week, the second being 2328: Space Basketball.

This hobby involves "collecting" and presumably using five-words-long technical jargon. In the comic, White Hat uses a phrases with five such words while talking to Randall (as Cueball), causing Randall to exclaim "cool" (as in what a cool sentence), and then proceed to type the phrase into his phone to add to his list of favorite Five Word Jargon.

Randall then proceeds to list his current favorites among really satisfying five word technical phrases (or jargon) as a caption below the panel, with White Hat's phrase as the last, possibly the newest. Maybe it was the one that caused Randall to consider other phrases and make this comic.

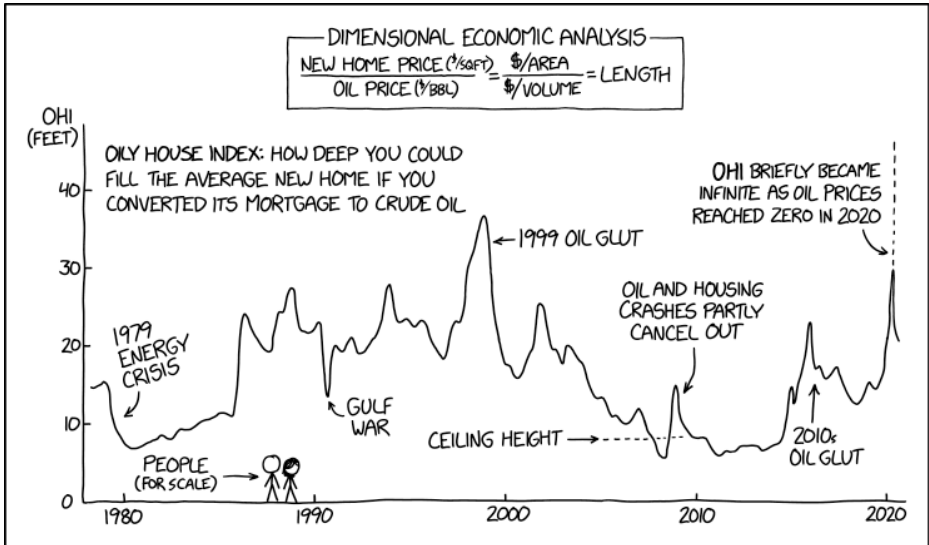
In the title text, Randall says that he has another much harder hobby, which is to engineer situations where he can use more than one of his favorite phrases. It would seem difficult to combine any of the four listed phrases in a given conversation, as they are from four separate fields (medicine, economics/statistics, biology, and physics/cosmology). However, he said "situations", which is broader term than "conversations". For example, someone could arrange for experts on these fields to deliver TED talks on these topics, so that he

could introduce them by saying "today, we will learn about..." and list the phrases, but Randall cannot, because he has been banned from TED. At least he has succeeded in using them together in this comic.

**Technical jargon[edit]**

## #2327: Oily House Index

July 01, 2020



We're underwater on our mortgage thanks to the low price of water.

## Explanation

In economics, an index is a statistical measure of change in a representative group of individual data points. Common indices include NASDAQ (a measure of a range of stock prices) and a consumer price index (a measure of retail prices)

This chart demonstrates an invented index, the "Oily House Index", which measures a ratio of oil price to average house prices, over time.

The numerator is the average price of a new home (presumably in the US), in USD per square foot (\$/sqft). It does not specify what kind of home, or where. One available metric is the average price per square foot of floor space in new single-family houses in the United States which was \$118.91 in 2019. The caption refers to converting the mortgage of the new house (that is, how much the purchaser borrowed, which could be zero), while the definition simply refers to the new home price (the total value). It is not clear which of these two is used in the chart.

The denominator is the price of oil in USD per barrel (\$/BBL). This is also not well defined, although the chart's caption suggests that it is based on crude oil. There are many different indices for different blends of oil in different locations, such as West Texas Intermediate, which is a crude oil commonly used as a global oil benchmark. (Others include Brent and Dubai

Crude). The WTI price fluctuated around \$55-60 throughout 2019. A barrel is a standard unit of oil volume, defined as 42 U.S. gallons (roughly 5.615 cubic feet or 0.16 cubic meters).

The comic then applies dimensional analysis to this index: dividing  $\$/\text{sqft}$  by  $\$/\text{bbl}$  yields a result whose dimension is a linear measurement, which can be called length. 1 barrel is 42 gallons, a gallon is 231 cubic inches, and a cubic foot is  $12^3=1728$  cubic inches, so a barrel is approximately 5.6146 cubic feet and a cubic foot is approximately 0.1781 barrel. The average price per square foot of a new single-family dwelling in the USA in 2019 was about \$119/square foot, while the price of oil in mid 2019 was about \$60/BBL or \$10.7/cubic foot. Dividing \$119/square foot by \$10.7/cubic foot gives approximately 11.1 foot. This is slightly lower than the value shown on the chart of around 15.

The chart's caption then interprets that length as the depth that a new home could be filled with the crude oil that could be purchased with its price. For scale Cueball and Megan has been drawn, and the ceiling height of a typical house has been indicated, showing that only in time with deep crisis will the oil not fill the house. It's also not exactly clear where the extra oil should go after a multi-story house has been filled; on the top floor, you could just take off the roof and let the oil pile up (perhaps after building some retaining walls), but on the lower floors, there's already oil above the ceiling.

The index is high when house prices are high and oil



prices are low (such as during the 1999 oil glut), and low when house prices are low and oil prices are high (such as during the 1979 energy crisis). See details about the chart below.

The title text, "We're underwater on our mortgage thanks to the low price of water", is a pun. A mortgage on a property is considered to be "underwater" when the value of the mortgage exceeds the value of the property. This is bad for both the owner (who owes more money than the property is worth) and the bank (who now have a loan which is not fully secured against a default: if the property owner defaults, the bank will lose money in selling the property)- though obviously far worse for the owner.

The title text is hinting at an alternative index based on the ratio of house price to the price of water instead of oil. At the 2019 rate of \$118.91/ft<sup>2</sup> and a rough average water price of \$0.0015/gallon, a house would have to be filled with water to a depth of 1060 ft for the house cost to match the water cost. If the price of water fell or the house cost per square foot rose, then the index would rise, causing the house to be even deeper in water (following the metaphor of the index as filling the house with physical water). This situation could arise even if the property value remained high, although Randall may be humorously suggesting that the increase in the index would literally flood the property with water, which would then damage it, obviously decreasing its value. (If the index continues to be computed on average house prices, then this single event would not materially impact

the index as a whole.)

In What If #11 "Droppings", Randall commented that "unit cancellation is weird" after making a similar calculation about fuel efficiency -- the European convention of presenting fuel mileage as "liters per 100 kilometers" represents an area (volume/distance), which can be physically interpreted as the cross-sectional area of a tube of gasoline with the total volume of fuel burned stretched out over the length of the journey.

**Chart[edit]**

## #2328: Space Basketball

July 03, 2020



MY HOBBY: PLAYING  
BASKETBALL AGAINST SPACE

My shooting will improve over the short term, but over the long term the universe will take more shots.

## Explanation

This is another comic in Randall's My Hobby series, released during the same week as his last hobby comic, 2326: Five Word Jargon.

Randall wishes to play basketball against outer space, hence the title Space Basketball. (His previous attempt at creating a "New Sports System" for multiplayer socially-distant basketball was not very successful.) His goal is to make thirty baskets in a row before the universe puts a meteor through his hoop.

It should be noted that while may be technically correct to call the falling space object in this case a "meteor", when it hits the ground moments later it would be known as a meteorite. See also Terminology section below. See also 1405: Meteor, for what Randall's thoughts are on this.

Randall estimates that his success rate at free-throw shooting is approximately 30%. Therefore, the chances of Cueball making 30 shots in a row is 0.330, or about 1 in five quadrillion ( $2 \times 10^{-16}$ ); for comparison, there are approximately 150 quadrillion seconds remaining before the Sun engulfs the earth (5 billion years), so if Randall has a chute set up under the basket and enough basketballs to sustain a constant high rate of shooting, he has "decent" odds of achieving his goal before the Sun burns out. But really, Randall has comparably rapid learning at this task, whereas asteroids have extreme

persistence far beyond Randall's life, so when he says the odds are comparable he is abstractly weighing his unique skillset against that of small stellar bodies.

Still, the lifetime odds of being killed by a meteorite have been estimated at 1 in 75,000 or 600,000 or 700,000 . These calculations are usually based on the probability of being alive at a time when a huge impact kills billions of people. Randall just uses the chance of one meteorite shot on Earth hitting this hoop (hoop-area divided by Earth-area =  $3.2 \times 10^{-16}$ ) which is in the same range as 0.330. Actual meteorite fall statistics report an average of 1.2 meteorites per year hitting the European continent which suggests that the average probability of Cueball winning after each shot attempt is about equivalent to a meteorite passing through the hoop over the period of 10 hours. Therefore Cueball has a better chance of winning than the universe "on the short term" if he makes more than 840 free-shot attempts per year for the rest of his life. The expected time for the universe to actually "complete" the challenge would be in the range of 8 billion years, the same magnitude to the current age of the universe and longer than the estimated remaining lifetime of the solar system.

In the title text, Randall assumes that he would get better at free throwing shooting with practice in his lifetime ("the short term"). Some of the world's best basketball players have free-throw percentages over 90%, and even professional players with reputations of being "poor" free-throw shooters (e.g. Shaquille O'Neal) are above 50%. If Randall can improve his percentage to 50%, his

odds of sinking thirty baskets in a row improve to "nearly" one-in-a-billion, while a member of the elite 50–40–90 club would have a probability better than four percent of making thirty free-throws in a row. Some specialists have achieved much higher success rates, with the record for most consecutive baskets being held by Tom Amberly with 2,750. The NBA regular season record is 97 free throws in a row, set by Micheal Williams in 1993 (during the 1992–93 and 1993 94 seasons).

However, he acknowledges that in "the long term" (the life of the universe, or at least the Earth), the Earth will be hit by very many meteorites; even though it is more likely that Randall will make his thirty free-throws before a meteor passes through his basket, he does not possess the cosmic lifespan[citation needed] required to surmount the odds against him and actually have a good probability to witness either event.

## **Terminology[edit]**

A piece of space debris falling through the atmosphere is a meteor.

A piece of space debris that makes it all the way to the surface of the Earth (or any planet) is a meteorite.

Most meteors burn up completely and do not become meteorites.

The concept of a meteor passing through a basketball hoop, ten feet or less from hitting the ground, is so uncommonly discussed that the terminology could be a matter of some debate. Unless it is very large, a meteor this close to the ground will have slowed to terminal velocity and will no longer be burning up[citation needed]; it will therefore not be incandescing like a conventional

meteor, and it is certain that it will become an actual meteorite within just a moment.

(Any meteor still incandescing within 10 feet of the ground, on the other hand, would presumably destroy both the basketball hoop and any nearby observer, meaning that poor Cueball, if still shooting, would lose the game in a much bigger way.)

Many scientifically-aware people have the habit of correcting "meteor" to "meteorite," so it may be safest to use the latter term among nerds other than Randall, or you could out-nerd them by pedantically pointing out a reason to still call it a meteor.

## #2329: Universal Rating Scale

July 06, 2020

UNIVERSAL RATING SCALE	
0	
1	
	STRONGLY DISAGREE
F	
☆	
	EXTINCT
TALL	
2	
G	
	CRITICAL
☹	
3	
	ENDANGERED
☆☆	
PG	
	DISAGREE
VG	
4	
	GRANDE
5	
	PG-13
☹	
6	
	T FOR TEEN
7	
☆☆☆☆	
	AGREE
VENTI	
8	
	LEAST CONCERN
☺	
A	
	STRONGLY AGREE
	CATEGORY 5
EF-5	
NC-17	
UNC	
AA	
☆☆☆☆☆	
A+	
S	
AAA	
10	
10.0	
11	

There are plenty of finer gradations. I got 'critically endangered/extinct in the wild' on my exam, although the curve bumped it all the way up to 'venti.'



## Explanation

In this comic, Randall has blended many traditional rating scales to create a "universal rating scale". Unfortunately, the mixing of these scales creates a scale that is impossible to use. Only a subset of the values of each rating scale is included, further weakening its claim as a "universal" scale. The result is much like the attempt to create a "universal standard" in 927: Standards.

Alternatively, it can be perceived as a way of comparing the different scales, for instance to answer a question like "Is it worse to get a 2 or an F?"

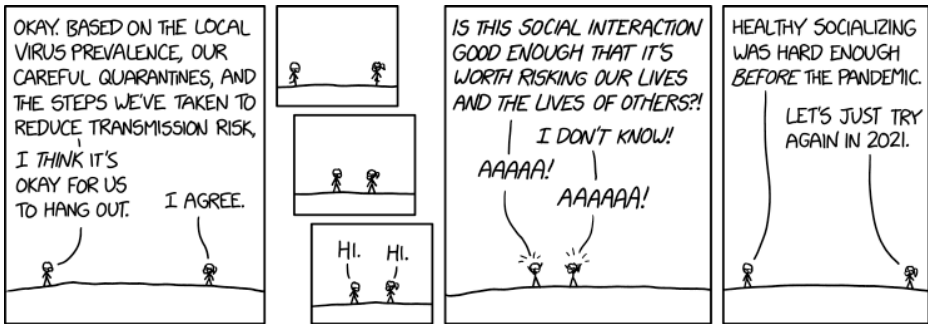
The title text suggests that the scale as shown here is incomplete, by referencing further gradings that are not shown in the table. Critically endangered and Extinct in the wild are real conservation status categories recognized by the IUCN, although it's not clear what "Critically endangered/extinct in the wild" would mean - perhaps the "possibly extinct in the wild" designation, abbreviated CR(PEW). It would presumably fit on the table somewhere between "Extinct" and "Critical", although its ordering relative to "tall", "2" and "G" is unclear.

The title text suggests that a score at this level had been graded on a curve, which bumped its rating up to "Venti", which is on the table, two steps below "Least concern". This would be an extraordinary example of such a curve, pushing the score from approximately 2/10 to almost 8/10. This could only happen if the exam was

extremely difficult, meaning most results were significantly below 2/10.

## #2330: Acceptable Risk

July 08, 2020



Good thing I'm not already prone to overthinking everyday decisions!

## Explanation

This comic is another comic in a series of comics related to the COVID-19 pandemic.

This comic shows Cueball and Ponytail, who are nervous to spend time in close proximity while the coronavirus is still widespread, and while lockdown procedures are still in effect across the world. Despite taking many precautions, such as wearing masks and maintaining physical separation, they still fear the effects of the virus, and attempt to weigh the value of actually seeing each other in-person versus potentially catching the virus. This is a dilemma faced by many, as the United States enters the fourth month since stay at home orders began. Cueball and Ponytail are particularly affected because they are known to overthink everyday decisions and interactions (in spite of their protestation to the contrary in the title text), as seen in e.g. 1445: Efficiency. Moreover, Cueball is bad at social interactions, virus or no virus, as pointed out in the last panel.

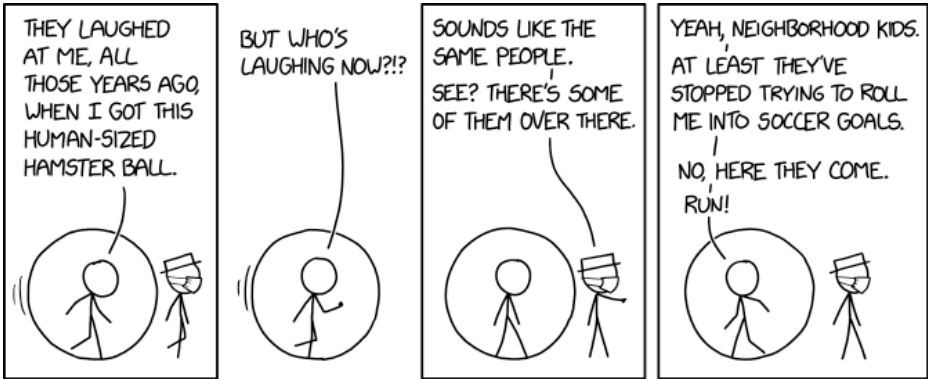
The comic title "Acceptable Risk" is formally used in risk assessments as a risk level that so low that it is comparable with other daily life risks. Typically, Acceptable Risk is defined as the probability of death being about one in a million. Cueball implicitly makes a risk assessment where he takes into account local virus prevalence and steps to reduce transmission risk coming to the conclusion that the risk to "hang out" is an acceptable risk. During the meeting however he becomes aware that for a good risk

control strategy he also has to consider the trade-off between the benefits of taking the risk of "social interaction" over the benefits of completely avoiding the risk. Additionally, the numerous precautions that Cueball and Ponytail have taken to reduce risk (wearing masks, meeting in a featureless empty field with no other people, maintaining a safe distance) likely make the social interaction much less enjoyable, and thus perhaps not worth it at all. Cueball and Ponytail figure that it is extremely hard to measure the benefits of social interaction for them, and thus decide that for now complete avoidance is the better risk control strategy.

Their screaming actually increases the risk of the interaction; this is why Japan recently banned screaming on amusement park rides (you read that right), and why many jurisdictions are levying particular restrictions on singing even when gatherings are permitted.

## #2331: Hamster Ball 2

July 10, 2020



The worst is being teased by responsible, mask-wearing teens. They even spritz the hamster ball with disinfectant before rolling it, carefully avoiding the filter vents.

## Explanation

This comic is another in a series of comics related to the COVID-19 pandemic.

A hamster ball is a small, transparent sphere in which a hamster or other pet rodent can run around (reasonably) safely, without being in its cage. Cueball had previously obtained a "human-sized hamster ball" for himself.

Cueball relates that, once upon a time, he was teased for this seemingly-frivolous pursuit, but he feels that now, in the midst of a worldwide coronavirus pandemic, having his own bubble to be inside is a smart move. He is contrasted to White Hat, who is wearing a facemask for protection.

"Who's laughing now" is a common phrase that you know better than others who originally laughed at you, or that the "tides have turned" and you have a control over the situation. However, as White Hat notes, the same people who laughed at Cueball before are still laughing at him, for the same reasons as before: even though his hamster ball has some practical utility now (enforcing social distancing), it still looks ridiculous and is lots of fun to roll around.

In the title text, Cueball says that he feels worst about being teased by "responsible, mask-wearing" teens, who treat the outside of his hamster ball as a potentially-contaminated surface (which it is, if it has

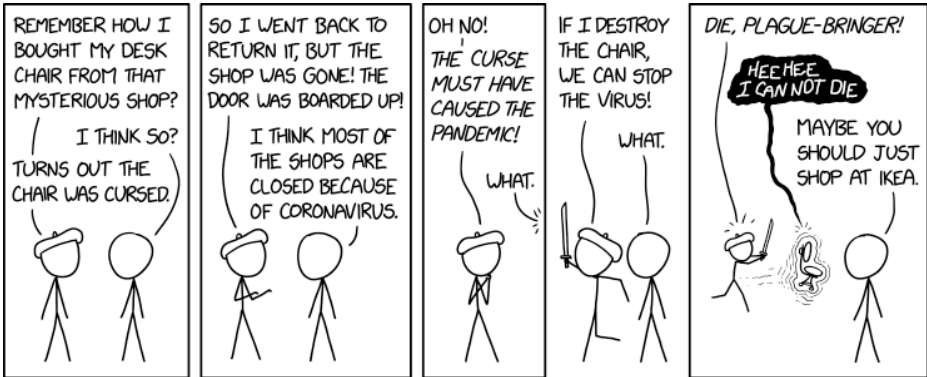
previously been rolled around by irresponsible teens who might have contracted and spread the coronavirus) and disinfect it, taking care to avoid spraying the vents and thus not exposing Cueball's lungs to a hazardous chemical, before rolling him around. It's not clear why he doesn't like being rolled around by responsible teens; it could be that he vindictively wishes that they would catch the coronavirus from the outside of his hamster ball, thus proving that he was correct to use it, or it could be that his ego is injured by the fact that even responsible and otherwise well-mannered and socially-conscious teenagers (who are not likely to be particularly harmed themselves by COVID-19, but conscientiously follow guidance to reduce transmission and protect those who are at-risk) find his hamster ball so ridiculous that they have to have fun at his expense.

As the title indicates, this is the second comic specifically devoted to hamster balls; the first was 152: Hamster Ball, in which Cueball wished for a genie to give him a human-sized hamster ball (and then had no other wishes he wished to wish). A human hamster ball also features prominently in 211: Hamster Ball Heist.



## #2332: Cursed Chair

July 13, 2020



The Wirecutter staff called the Herman Miller Siegel Perilous "the most cursed product we've ever had to fight" and "nearly as immortal as it boasts."

## Explanation

This comic is another in a series of comics related to the COVID-19 pandemic.

Beret Guy informs Cueball that he purchased a cursed office chair from a mysterious shop. Cueball isn't sure if he remembers this happening, which is possibly because Beret Guy has previously stated that he makes a habit of purchasing daily necessities from such stores. Beret Guy then exclaims that the store he bought the chair from was gone when he went to return it, though given his buying preferences, he should perhaps not be so surprised. Cueball suggests that maybe the shop was simply closed due to the COVID-19 pandemic, as is the case for wide variety of non-cursed businesses.[citation needed] Beret Guy takes this as proof that the chair somehow caused the pandemic, a claim Cueball meets incredulously. In the final panel, Beret Guy is doing battle with the chair, which taunts him and claims to be immortal ("I can not die"). In fact, most chairs cannot die, because they are not alive.[citation needed] Cueball remarks that it would be simpler to shop at IKEA, a store famous for its minimalist flat-pack furniture, and which usually does not sell cursed items[citation needed] (although they do sell "miniature Dyson spheres").

The cursed chair and the boarded-up store are references to the stores that sell cursed items mentioned in 1772: Startup Opportunity. In that comic, the stores vanished without a trace. But the fact the door was boarded is

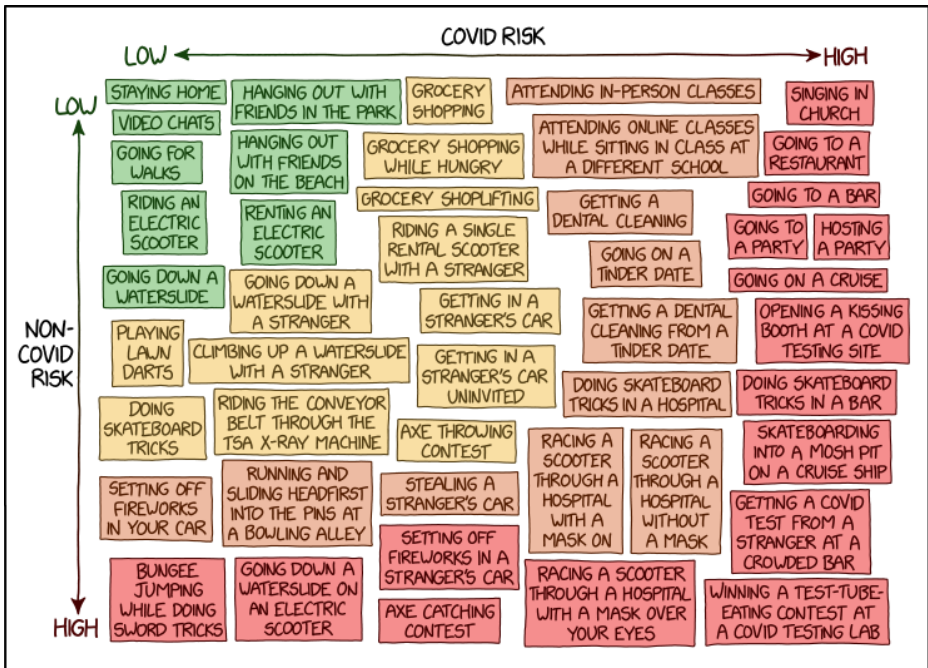
much more likely due to the pandemic or other causes than the store mysteriously disappearing.

Buying an item from a shop you never noticed before, bringing it home, discovering it is cursed, and trying to return it only to discover the shop isn't there anymore is a popular trope. See *The Little Shop That Wasn't There Yesterday*.

In the title text, the Siege Perilous is the empty seat at the Round Table in Arthurian legend, reserved by Merlin for the knight who would find the Holy Grail (who turns out to be Sir Galahad) and fatal to anyone else who sits in it. Herman Miller is an American office furniture company that produced the Aeron chair, which is the basis for an artwork by Glenn Kaino called *The Siege Perilous*. Wirecutter is a website that evaluates and recommends consumer products. From the title text, it sounds like (in the xkcd universe) Wirecutter is used to encountering cursed products,[citation needed] so they didn't even bother trying to sit in it to test the Siege Perilous's perilousness (er, peril) before they started fighting it—and emerged victorious, if it's only nearly as immortal as it boasts.

## #2333: COVID Risk Chart

July 15, 2020



First prize is a free ticket to the kissing booth.

## Explanation

This comic is another in a long series of comics related to the COVID-19 pandemic, which was ongoing at the time of his comic being released.

This comic is a graph showing the risk of COVID-19 infection of numerous activities on the horizontal axis, while showing the other (i.e. safety) risks of the activity on the vertical axis. The activities are also color coded green, yellow, orange, or red, presumably indicating whether engaging in them is a good idea. All the activities are green in the upper left corner (no COVID-19 danger and no other dangers), but change to yellow, orange, and red as you go right or down. This presentation and color progression is similar to a common presentation of a risk matrix.

One-dimensional charts showing the COVID-19 risk of common activities were popular at the time of this comic, when businesses and schools were re-opening after the first wave of COVID-19.

The top of the graph contains activities that people are likely to engage in during the pandemic, beginning (from left to right) with staying at home, hanging out with friends at the park, grocery shopping, attending in-person classes, and singing in church. The first few activities are common and not very dangerous (colored green and yellow), but the last two come with significant risks of infection due to COVID-19 (they are colored orange and red). Lower on the graph the activities

become more and more dangerous (though these dangers are not related to COVID-19, i.e.: they are non-covid risks) and then non-sensical, a trend often seen in xkcd comics. Some activities are grouped together, being variations of the same thing (such as going down a waterslide, going down a waterslide with a stranger, and going down a waterside on an electric scooter). The last row contains extremely dangerous activities such as (from left to right, or from low COVID-19 danger to high) bungee jumping while doing sword tricks, going down a waterslide on an electric scooter, (participating in an) axe catching contest, racing a scooter through a hospital with a mask over your eyes, and winning a test tube-eating contest at a COVID testing lab. All these activities are likely to result in undesirable outcomes.[citation needed]

Part of the humor comes from the increasing ridiculousness of the "red" activities, some of which are unlikely combinations or escalations of other less-risky activities (e.g. renting an electric scooter is a "green" activity, but riding that scooter with a stranger carries more risk, and then still more from racing that scooter through a hospital, with or without a mask).

This comic strip is similar in presentation to 2282: Coronavirus Worries.

The title text suggests a ticket to "the" kissing booth as a prize. Presumably, the prize is for the test-tube eating contest, and the booth is the kissing booth mentioned in the comic, "a kissing booth at a COVID testing site". A

kissing booth is a kind of sideshow sometimes seen at carnivals, where members of the public can pay a small fee to kiss someone, usually an attractive woman. Winning a ticket would normally be positively received. However, since kissing is a very high risk activity for COVID-19 transmission, it would now be perceived as a kind of punishment. Moreover, if the ticket was the prize for the test-tube eating contest then not only would the winner already likely have infected themselves with COVID-19, but they are likely to have mouth injuries from eating glass, making the kiss even riskier.

### **Green[edit]**

The lowest-risk category of activities has very low COVID risk and also very low non-COVID risk.

### **Yellow[edit]**

The medium-risk category of activities has medium COVID risk and also medium non-COVID risk.

### **Orange[edit]**

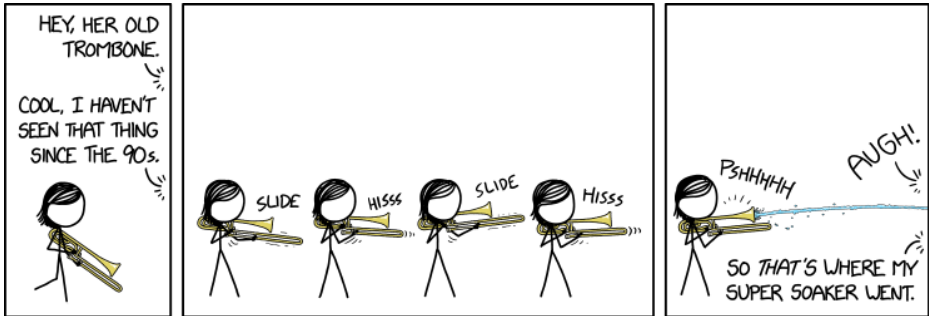
This is where things start getting serious. This category of activities has a higher COVID risk and same for the non-COVID risk.

### **Red[edit]**

This is where things start getting really serious and even somewhat absurd. This category of activities has the highest COVID risk and the highest non-COVID risk.

## #2334: Slide Trombone

July 17, 2020



Remember the CPS 2000, the super soaker that was discontinued because it was too powerful? Relatedly, can I borrow your tuba?



## Explanation

In this comic, Megan carries her "old" trombone, a brass musical instrument with a movable sliding piece used to change a musical note's pitch, which those offscreen apparently haven't caught sight of since the 90s (presumably the 1990s). These offscreen people don't suspect anything unusual of Megan's trombone until it turns out that it contains a water gun, which she uses to soak the other characters. It is unclear whether she has somehow hidden the water gun inside the trombone, has disassembled it to produce a hybrid trombone/Super Soaker device, or otherwise modified the trombone such that it can shoot water as a water gun would.

In the second panel, she is priming the water gun by pumping air into it, following the sequence of pump actions used for the Super Soaker. During the first "slide" action, the user pulls the grip towards themselves, increasing pressure within the water reservoir of the gun. During the second "hiss" action, this grip is pushed away; a valve prevents air leaving the chamber, though a small amount usually leaks out. Part of the joke here is that a slide trombone also has a slide mechanism, held in a similar way as that of the Super Soaker, but which serves a completely different purpose. In the case of the trombone, when the slide is extended, the total length of tubing between the mouthpiece and the bell is extended, thereby lowering the pitch of the sound that is produced (there is, however, no comparable air chamber). This similarity between the two devices enables Megan to use

the trombone's slide as if it were a Super Soaker's.

In the third panel, she presses the trigger, causing the compressed air within the water reservoir to push water from it at high speed, hitting the off-screen targets. One cries out in surprise, while the other expresses the realization of what had happened to their lost Super Soaker (that Megan had taken it as an alteration to her trombone).

In the title text, Megan asks those offscreen about the CPS 2000, a water gun which, as is mentioned, was powerful but too powerful, causing injuries to those shot by it and allegedly leading to its discontinuation. Megan then, in connection with her previous question about the Super Soaker, asks to borrow a tuba, most likely to hide the CPS 2000 water gun inside. Her reasoning behind needing this tuba seems to be that the CPS 2000 is seemingly larger than the Super Soaker originally stored in Megan's trombone and thus would require a larger vessel (this use of the tuba may be cause for loss of friendship with an experienced player).

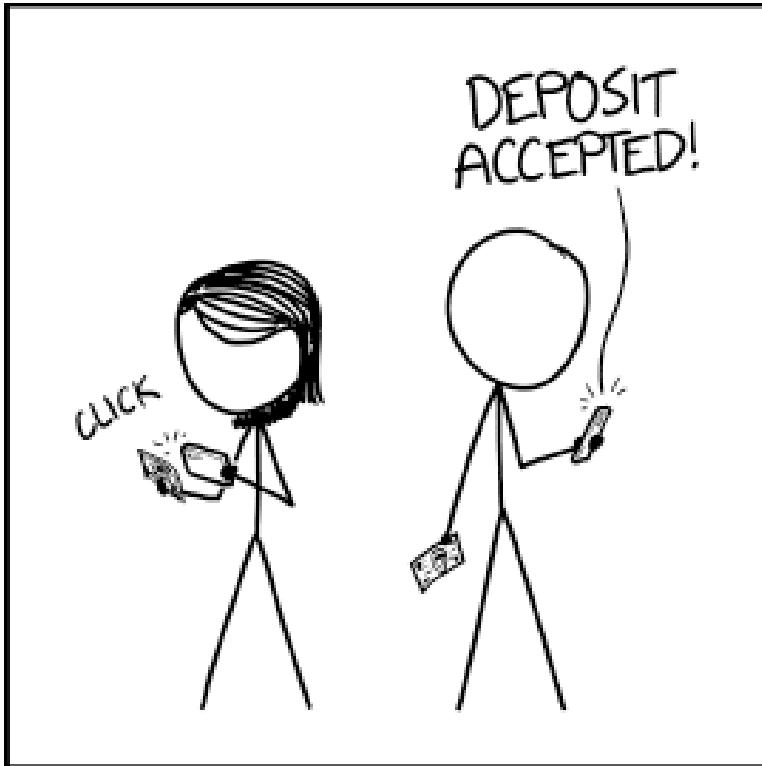
The CPS 2000 referenced by Megan was developed primarily by Lonnie Johnson and Bruce D'Andrade for Larami's Super Soaker product line. The "CPS" within its name refers to the "Constant Pressure System" used in certain water guns (its technology can be seen in this patent by Bruce D'Andrade). In this system, a rubber bladder within the water gun is pressurized by the user's pumping action, which draws water from a reservoir and pushes it into the pressure chamber, filling the bladder

like a balloon. Once the desired volume of water is stored within the toy, the water can be released by means of a spring-loaded trigger and valve system. Upon release, the rubber bladder pushes the water out of the pressure chamber and out of the front nozzle, hitting whatever targets the user desires it to. The "constant pressure" of the CPS's name refers to the fact that the bladder will exert the same pressure on the water throughout the shot, ensuring consistent power and range, as opposed to air pressure Super Soakers, whose power will die off during the shot as the pressurized air within the pressure chamber expands, expelling the water but reducing the pressure in the toy.

The Super Soaker that Megan uses in this comic is also referenced in 220: Philosophy and 517: Marshmallow Gun. If the water gun featured in this comic is the same as that depicted in previous comics, it would likely be a Super Soaker 50, the first widely available pressurized water gun. It could also be the less common but earlier model the Power Drencher or the later SS 50 Classic Series, Super Soaker S.E., or the 20th anniversary SS 50 rerelease.

## #2335: Photo Deposit

*July 20, 2020*



AFTER A LUCRATIVE SIX HOURS FOR US,  
OUR BANK REMOVED THE NEW FEATURE  
IN THEIR APP THAT LET YOU DEPOSIT  
CASH BY TAKING A PICTURE OF IT.

It's okay, they scan the serial numbers and make sure you  
can't deposit the same bill more than once.

## Explanation

Some mobile banking apps allow users to deposit checks through the app, by photographing the check and entering the relevant information. The comic parodies this imagining a bank that allowed you to "deposit" banknotes via a mobile app, by taking photos of them. The caption implies that this attempt is predictably disastrous, as it's shut down within six hours.

Checks are essentially documents instructing a bank to disburse funds from a given account to a specified recipient, hence electronic transfers make sense: the recipient's bank can transfer the image to the depositor's bank and the funds can be transferred between the two. The check could only be deposited by the recipient, and any attempt to deposit the check repeatedly would be refused (and potentially subject the recipient to legal action). By contrast, cash functions as a bearer instrument, where physical possession of the banknotes effectively constitutes possession of the funds. Hence, depositing cash electronically would make little sense, as the depositor would still have the notes (and therefore the money), and the bank would not. Such a transaction would enrich the depositor at the expense of the bank.

The title text states that the app recognizes the serial numbers on the bills and prevents users from depositing them multiple times. However, this would not solve the fundamental problem. Clients could still deposit all of their cash and retain ownership of it. And they could

then exchange those bills for different ones and deposit the new bills, repeating the process indefinitely (which explains Cueball's comment about "a lucrative six hours"). It is possible that Megan and Cueball are deliberately depositing the same bills to each of their accounts, given their close proximity.

The only way such a system could work is if every entity that accepted cash payments or deposits operated from a common database, functioning in real-time, which kept track of each transaction, and disallowed any further use of that specific bill. This would have the ultimate impact of making cash virtually useless, as once every bill had been spent once, all future transactions would need to be electronic (unless there were a system in place to physically distribute the appropriate bills to the appropriate people, which would defeat the entire point). Such a system is essentially the basis for cryptocurrency, which uses a crowd-sourced system to track the movement of money. But such a system would require virtually universal acceptance in a given country, and could not be implemented by a single bank.

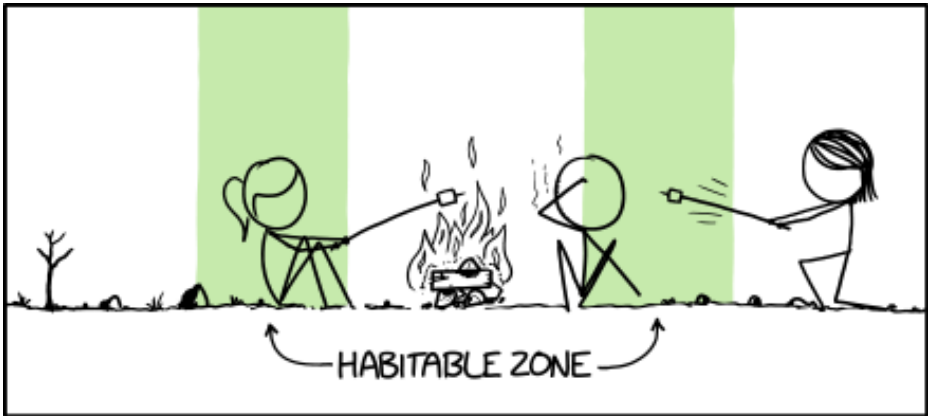
In addition, the system would be highly vulnerable to counterfeiting. Common anti-counterfeiting measures include using distinctive materials and fine details, both of which are difficult to duplicate well enough to fool a human. Smartphone cameras, on the other hand, can't distinguish texture and may not have sufficient resolution to make out that level of detail. Counterfeiters could produce and deposit an almost unlimited number of bills, then destroy them, leaving little evidence of their

crime.

As a result, this system would be inherently unworkable, and the party that would suffer from it would be the bank that implemented it in the first place. Which makes it realistic that, if a bank were to implement such a scheme, they'd very quickly realize their error and put an end to it. This is why the bank took down this system.

## #2336: Campfire Habitable Zone

July 22, 2020



ASTRONOMERS DEFINE THE CAMPFIRE HABITABLE ZONE  
AS THE REGION WHERE YOU'RE FAR ENOUGH NOT TO BE  
BURNED BUT CLOSE ENOUGH TO ROAST MARSHMALLOWS.

Oh no, my marshmallow became tidally locked!



## Explanation

This comic plays on the concept of the astronomic "habitable zone" applied at the scale of people sitting around a campfire.

The habitable zone of a star is the range of distances in which a planet might support liquid water, and hence life in the only form that we currently know of (as an allusion to the "not too hot, not too cold, but just right" of the related children's story, the habitable zone is also commonly known as the "Goldilocks zone"). If the planet is too close to the star, then the amount of stellar radiation would be too great, causing the water to boil; too far from the star, and the planet doesn't have enough radiation, causing the water to freeze (although for life to actually exist, the planet itself must also have the right mass in order to maintain a life-compatible atmosphere and meet other such requirements). For our Sun, the habitable zone is estimated to range from about 0.38 to 10 astronomical units, where 1 astronomical unit is the distance from the Sun to the Earth.

Marshmallow toasting is a popular camping activity in which people place a marshmallow (a soft, sugary blob made of gelatin and covered in corn starch) on a stick and over/near a fire. As the marshmallow cooks, the inside becomes gooey while the outside becomes crispy (perhaps slightly charred and maybe even burned, depending on the toaster's preference), making it tastier via caramelization and the Maillard reaction.

In the context of the campfire, a similar "habitable zone" is posited by Randall to exist: a zone which is close enough to the fire such that the person can comfortably toast marshmallows, presumably on a stick of reasonable length (the ones in the comic seem to be about 1.5 times an arm's normal reach), yet far enough such that the person is not uncomfortably hot or even burned by either direct contact with the flames or by exposure to the radiant heat of the fire.

To demonstrate this hypothesis (with the habitable zones marked in green), Cueball is shown sitting outside the right habitable zone on the side of the fire. Even though he is able to toast his marshmallows on the fire due to his being close to it, he will have and is having part of his body scorched, as he is too close (fires can get really hot). Megan, also on the right, is well outside the habitable zone on the side away from the fire. Although not burned, the marshmallow on the stick she is waving will presumably not toast due to its being too far from the campfire. Ponytail, on the other hand, has found and is enjoying the medium between the plights of both Cueball and Megan by sitting entirely within her (the left) habitable zone, thereby both being close enough to the fire to be able to toast her marshmallows while also staying far enough away such that she will not be burned.

The title text introduces the concept of tidal locking, in which one astronomical body synchronizes its rotation with its orbit around another such that one side always faces the other body (e.g. the case of Earth's moon, which always presents the same face to the Earth). The joke here

is that if a marshmallow became tidally locked to the fire, then one side would become more and more cooked, perhaps burnt, while the other side never became toasted at all. This also may allude to the instance in which a marshmallow has begun melting more than you realized and dripped down so far that it no longer responds to your rotation of the roasting stick (the solution to which is to cut your losses and pull the marshmallow out immediately, before it drops into the fire pit).

## #2337: Asterisk Corrections

*July 24, 2020*



I LIKE HOW WE CAN DO CORRECTIONS  
IN TEXT CHAT BY APPENDING WORDS  
WITH ASTERISKS AND OUR BRAINS  
JUST FIGURE OUT WHERE THEY GO.

I like trying to make it as hard as possible. "I'd love to meet up, maybe in a few days? Next week is looking pretty empty. \*witchcraft"

## Explanation

In text messaging etiquette, asterisks are commonly used to denote a correction of some error in an earlier text. Asterisk corrections typically specify the corrected words, but do not explicitly mark the words that should be replaced, the reader is expected to understand which word is being corrected. Typically, this is due to a typo or autocorrect issue, so the corrected word will be similar to the original, but this comic plays with the fact that the words can be completely different, and most people will still understand it.

In the strip, the messenger (Randall) issues four corrections, which replace words with completely different words, and entirely change the meaning of the message. The original message is "I'm gonna ride a horse on the beach at dawn", suggesting a life of adventure and romanticism. The corrected version comes out "I'm gonna eat a pizza on the couch at 3 am", suggesting that his plans are unimpressive, and may indicate a slothful and unhealthy existence.

Randall finds it remarkable that these corrections can be issued, with no indication of which words they're replacing (and aren't even issued in the proper sequence), and most people have very little difficulty figuring out the corrected message. This is likely possible because the syntax of most English sentences are as follows:

After a lifetime of practice with this language structure,

the typical human brain can very quickly identify the nature of each word, and slot them into their proper place in the sentence, often without any conscious effort.

Other languages have different word orders but generally have the same six categories.

The messenger's original sentence can be parsed as follows:

Notice that the four corrections fall into four different categories in this structure, so there is only one sensible replacement:

- Eat: verb
- 3AM: time
- Couch: place
- Pizza: object

"Couch" and "pizza" are both nouns so they could theoretically be subjects, but asterisk corrections must replace an existing part of the sentence satisfactorily, so the "'m" part of the verb prevents these third-person nouns from being parsed as the subject. Theoretically one could also swap "couch" and "pizza" around, giving "eat a couch on the pizza", but this makes much less practical sense than "eat a pizza on the couch". That said, in xkcd's fictional universe there is nothing to stop the character from eating a couch on a pizza. Perhaps Beret Guy is the one texting.

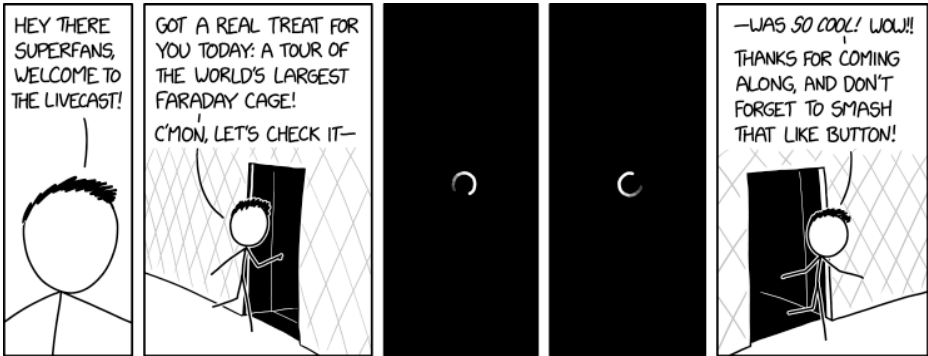
In the title text, Randall says that he likes to make it as

difficult as possible for his text recipient to guess where his correction should be, and uses the following sentence and correction:

The trick here is that the word "witchcraft" doesn't fit into the sentence in any obvious way, and attempting to fit it in results in a sentence which is either very odd or grammatically meaningless. This creates a bit of mental tension, as many people's minds will try to find ways to make it work, even though none exist.

## #2338: Faraday Tour

July 27, 2020



I asked them if it was safe to be running tours during the pandemic. They said, "During the what?"



## Explanation

This comic is arguably another in a series of comics related to the COVID-19 pandemic.

Hairy, addressing an unseen camera (possibly the reader's POV) welcomes viewers to a livestream broadcast - that he calls/brands as a 'Livecast' - walking through "the world's largest Faraday cage." A Faraday cage blocks electromagnetic transmission into and out of the cage area. Attempting to broadcast a walk through such a cage with any medium that uses radio waves would (theoretically, at least) cause the transmitter's signal to drop out completely, resulting in the loading wheel shown in panels three and four. Faraday cages do not necessarily have to be dark inside, as this one appears to be (they typically block longer wavelengths than those of visible light, which consists of electromagnetic waves). However, the darkness visually aligns with the concept of communications blackout, which is what Hairy's viewers experience while Hairy is in the cage. The darkness could be taken as a metaphor for depending so heavily on electronic connectivity for one's view of the world that anything not directly connected is conceived as unobservable. (Alternatively, the light switch could be inside the cage.)

The Faraday cage that Hairy is visiting may also be an anechoic chamber for testing radio equipment, which would be completely lined with radiation-absorbent material, not just an open-air cage, to ensure that the

measurements inside are of the highest quality. There's no particular reason that it would have to have the lights off for his tour (in fact, it would be better to have the lights on so that he could see the features inside),[citation needed] but some anechoic chambers have been used for sensory deprivation experiments, in which participants are shut inside in total darkness and quiet.

"Smash that like (or subscribe, etc.) button" is a typical command given by YouTubers to watchers, asking to publicly "like" the video or subscribe to their channel if they enjoyed it, ultimately to boost the creator's popularity. Developers want lots of views, likes, and subscribes because YouTube pays artists (e.g. \$1 per 1000 views).

The title text refers to COVID-19 pandemic of 2020. The joke is that, as they don't get cell service in the cage, the owners would be unaware of global events. This implies for comedic effect that the owners and workers solely live inside the Faraday cage, continuing the theme of treating connectivity as the only way to acquire information. They would still be able to receive news if they ever step outside to welcome visitors, have print media delivered or have a wired internet connection (perhaps even optical) fed through its walls. But their choice to unconventionally isolate themselves might reflect their general attitudes to the world outside, and it is also implied that Hairy is one of the rare few outsiders they have pre-agreed to allow to visit. Or one of the few people who would think to ask for and plan a tour during a pandemic.

Randall has referenced Faraday cages for comedic effect in the past. See 1142: Coverage.

## #2339: Pods vs Bubbles

*July 29, 2020*



THIS IS PROBABLY MY OPINION THAT  
WOULD HAVE SOUNDED THE MOST  
INCOHERENT TO ME A YEAR AGO.

Canada's travel restrictions on the US are 99% about keeping out COVID and 1% about keeping out people who say 'pod.'

## Explanation

This comic is another in a series of comics related to the COVID-19 pandemic.

During the 2020 COVID-19 pandemic, various degrees of household self-isolation were often asked of people, depending on location, once it became understood that there was a virus spreading through contact/proximity vectors.

As the initial surge of cases appeared to decline, in places where such drastic restrictions had been implemented and seemingly had prevented ever higher infection rates, many regions decreased the strictness of these measures. For instance, permitting any two households (neither having signs of symptoms) to meet with each other and only each other, or allowing one person in a multi-occupancy residence to invite just one other person to reassociate with. Further relaxation of rules may have occurred since, with the caveat that even one case of COVID-19 discovered in such a co-isolating group of people should be considered a risk factor to every other member (however the local jurisdiction deals with that).

A common term for the larger social unit, not to overlap with any other expanded social unit, is a 'bubble', perhaps to imply that you can only have membership of one bounded bubble at a time (unlike an Euler diagram). The term 'build your bubble' was coined by Dr Ingham

(University of Otago, New Zealand) as a way of encouraging people with disabilities to create safe 'bubbles' with care givers during lockdown. Another common term is 'pod', representing the closed nature of a pod. There is probably as much variation across the world about what podding or bubbling practically means as there is between any two instances of those podded vs. those bubbled. Some sports leagues have resumed play in these structures, with the media using the bubble terminology, both in the United States and across the wider world, as players and commentators alike resume some degree even of international competition (so long as they follow the 'bubble' rules).

Despite the semantic inconsequentialities of the difference, here Cueball clearly expresses a personal preference that he would probably not like being kept in an enforced social situation with someone who uses the other term.

Randall realizes that, despite his tendencies towards strong opinions on semantics, this particular point is one he would have been highly unlikely to say a year ago, and probably would not even have understood what it meant, because he could not have foreseen the COVID-19 pandemic and its widespread impact.

Cueball was shown using a literal bubble (a hamster ball) in 2331: Hamster Ball 2, but evidently got tired of being rolled around by the neighborhood kids.

The title text refers to travel restrictions. Many countries

have placed limitations on its citizens' travel, particularly in and out of that country. Canada has mandated 14-day self-isolation on anyone who has returned from out-of-country, and has strictly limited any attempts to leave the country, with the United States being specifically noted as a high-risk tourism destination. Randall jokes that such measures are only 99% meant as COVID-19 precautions, with the remaining 1% being due to the authorities sharing Randall's semantic opinions.

## #2340: Cosmologist Genres

July 31, 2020

### MUSIC GENRES ACCORDING TO...

...NON-COSMOLOGISTS

...COSMOLOGISTS

POP	LITE
ROCK	METAL
HIP HOP	METAL
METAL	METAL
COUNTRY	METAL
DANCE/ELECTRONIC	METAL
LATIN	METAL
PUNK	METAL
CLASSICAL	METAL
JAZZ	METAL
FOLK	METAL

Inflationary cosmologists call all music from after the first  $10^{-30}$  seconds "post-"



## Explanation

A cosmologist is someone who studies the universe; cosmology is a branch of astronomy. When describing the composition of stars in astronomical terms, metals are all the elements heavier than helium. This definition of metal is significantly broader than the one used outside astronomy. Likewise, this chart of musical genres describes everything "heavier" than pop as metal. The standard conception of elemental metals is a subset of the astronomical conception of metals; likewise, here the musical genre metal is presented as a subset of the genres cosmologists consider metal.

Randall may have decided to portray pop music in a similar way to the elements helium and hydrogen as a reference to the "pop test", the test for hydrogen as a product of a chemical reaction. Possibly simultaneously, he may be thinking of how one might "pop" a helium balloon, thus the "pop" analogy pulls double duty as a reference for both elements.

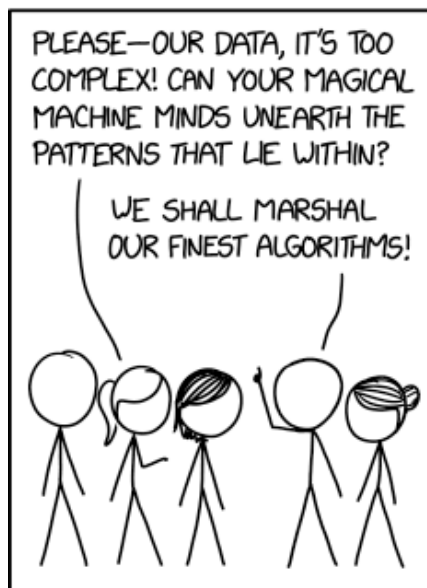
Cosmologists also study the history and future of the universe, and the title text refers to the Big Bang. At roughly 10<sup>-32</sup> seconds after the Big Bang, the inflationary epoch ended, causing a large number of quarks, anti-quarks, and gluons to come into existence. In inflationary cosmology, this point is considered to be the end of the Big Bang. Randall jokingly refers to it as "post-" because nearly the entire history of the universe is after this instant. This is a reference to types of music

with "post-" in their names, e.g. post-rock, post-punk, post-metal.

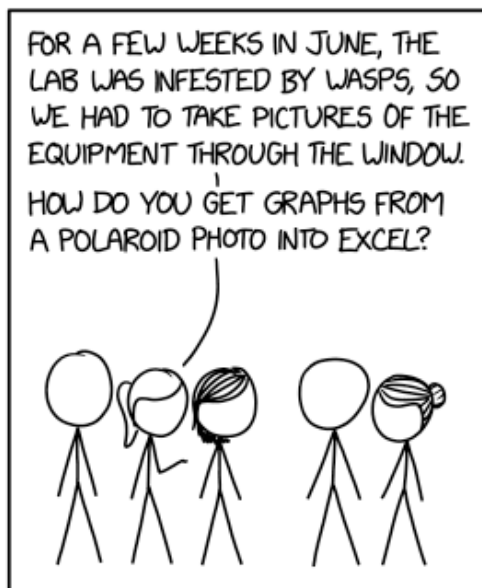
## #2341: Scientist Tech Help

August 03, 2020

WHAT TECH PEOPLE THINK  
SCIENTISTS NEED HELP WITH:



WHAT SCIENTISTS  
ACTUALLY NEED:



I vaguely and irrationally resent how useful  
WebPlotDigitizer is.

## Explanation

In this comic, Randall pokes fun at stereotypes of scientists that "tech people" hold.

In the first panel Randall, presents an idealized view of the tasks of tech people. A group of scientists have run their experiments and compiled their data, but find that the data is simply too complicated for humans, even advanced scientists such as themselves; the tech people resolve in heroic statements to decipher the data with their most advanced algorithms. Large portions of machine learning and data science hinge around finding a pattern (either regression or classification) in a given data set, but the more common, real-world problem is in data cleaning and preparation. For the most part, the rest can be done with preexisting implementations. These types of tasks are those that tech people both expect to perform, and hope to expand upon.

The second panel presents a different reality. The scientists are fully confident they can interpret the data on their own, provided they can access it, because the methods of recording their data are incredibly sub-par. Apparently wasps had infested the lab, and the scientists had to take photos of their equipment through the window. This created a much more fundamental problem of data format than normal (image vs spreadsheet, as opposed to something more normal like pixel-wise vs vertex-based segmentation). The joke is that the scientists' questions for their tech specialists are very

mundane in nature; it presents not a chance to test and prove their machine learning systems, but a simple and tedious process of untangling digital paperwork. This is true in real life — experts' expertise is usually deep, but not broad, and helping them with issues outside their comfort zone is rarely glamorous.

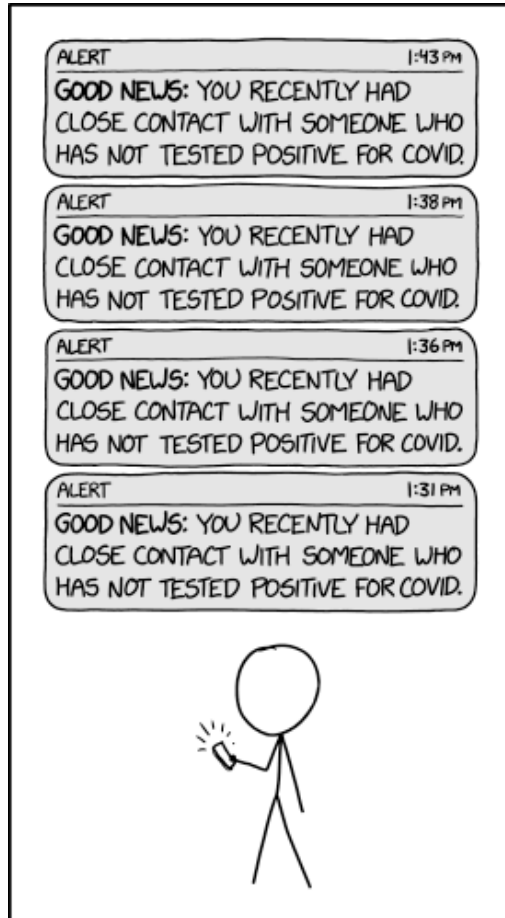
Polaroid is a brand of instant camera, though "Polaroid" is often used to refer to instant cameras in general. Excel is referring to Microsoft Excel, a spreadsheet management program.

The title text refers to WebPlotDigitizer, a tool which may be used on visual displays of data such as graphs and charts in order to extract the underlying data. This tool would have the potential to solve the problem which the scientists have by extracting data from the images taken of the equipment. Randall acknowledges the usefulness of the tool, but also expresses some dislike that the tool was invented at all — someone must have had the original data to draw the graph, thus if they had made the data available then he wouldn't have to reverse engineer the plot. Other possibilities are that he simply feels that the tool is too powerful and leaving him less work to do, or that tools so trite and seemingly unnecessary prove so useful in the end.

2116: .NORM Normal File Format deals with nested file formats.

## #2342: Exposure Notification

August 05, 2020



NO ONE LIKES MY NEW COVID  
EXPOSURE NOTIFICATION APP

I don't see why everyone is so hungry for **BAD** news, but fine, I'll give in to feedback and add a dark mode.

## Explanation

This comic is another in a series of comics related to the COVID-19 pandemic.

During the coronavirus pandemic, many apps were developed to implement digital contact tracing, using proximity detection or location tracking to notify people who had been potentially exposed to COVID-19. People who know they are infected are encouraged to isolate, and it takes time to test and find out if somebody is infected; so most notifications are retrospective, telling the user about past potential exposures.

In this comic, a different type of app has been developed. Instead of notifying someone if they have been exposed to someone with COVID-19, the app produces notifications if they have been exposed to someone who has not tested positive. (Perhaps it also notifies the user if they have been exposed to a person who has tested positive, but if this is the case, it hasn't happened to the user in question yet.) This is much less useful because most people one would typically encounter would either not be infected, or not be aware of their infection, so almost every interaction will generate a notification, annoying the user. Also, being exposed to someone who has not tested positive is not good news, because it is still possible that the person might have COVID-19; it is simply less bad than being exposed to someone who has tested positive, but still worse than not being exposed to anyone.

Socially and psychologically, modest amounts of people being close to each other normally is a positive behavior. For a typical person, it could be considered a sad sign of our times if you needed an app to tell you whether you did right in social interactions and compliment you. (For socially awkward people, on the other hand, this could be a welcome development.)

In the title text, Randall decides to give in to users requests, and add a mode giving the bad news that you have been exposed to COVID-19. Calling this dark mode is a play on dark referring to less desirable, as well as dark mode, a common user interface option. Dark mode is a common feature in apps which allows users the options to have a user interface that gives off less light. Alternatively, it may just be that the developer is completely misunderstanding the user's actual needs. This would be consistent with creating an app that alerts the way this one did in the first place.

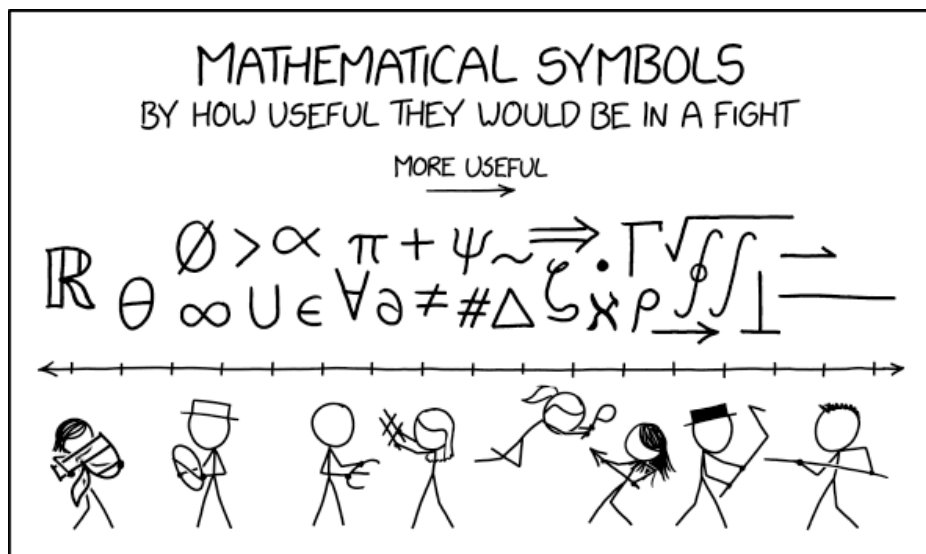
Randall has published similar "useless useful apps" in 937: TornadoGuard (a tornado-alert app that has lots of great features, except it doesn't actually alert the user about tornadoes) and 2236: Is it Christmas? (a web page that correctly identifies most days as "not Christmas", but then fails to identify Christmas Day as Christmas, for a >99% "accuracy").

A week after this comic was posted, a user of the Canadian COVID tracing app posted an article about a similar issue: notifications from non exposure.



## #2343: Mathematical Symbol Fight

August 07, 2020



Oh no, a musician just burst in through the door confidently twirling a treble clef.

## Explanation

This comic imagines which mathematical symbols would be good in a fight if they were made corporeal in two (or three) dimensions.

Generally, objects with longer reach and pointier ends wound up on the right ("more useful") side of the scale, and symbols with less reach and more curves wound towards the left ("less useful") side. A straight line is farthest to the "more dangerous" side; however, the straight line does not appear to be any thicker or thinner, or pointier, than any of the other lines that would make it more "useful" (It should be noted that this chart seems to fall afoul of what Eliezer Yudkowsky (who also wrote HPMoR) calls the intent to kill: that humans tend to define "winning a fight" and "useful" as causing some form of bodily harm on their opponent despite survival and purely defensive strategies being an equally valid goals.).

Below the chart, with the symbols listed in order of usefulness, eight characters wield eight of the symbols. See the table below for the meaning of each symbol.

The comic invokes surreal humor by suggesting that mathematical symbols could be handled as physical objects in the real world. Another component of the humor is the implication that it is useful to prepare to use mathematical symbols in a fight, even though mathematicians, who use mathematical symbols, usually

do not conduct their debates violently (though some stories suggest that Hippasus was killed by his fellow Pythagoreans for his proof that irrational numbers exist), and even if they did, they wouldn't use large reproductions of their symbols as weapons.

Note that Black Hat and Danish are using two of the most useful symbols, and appear to have teamed up against their opponents, resulting in an unfair advantage they would both absolutely exploit.

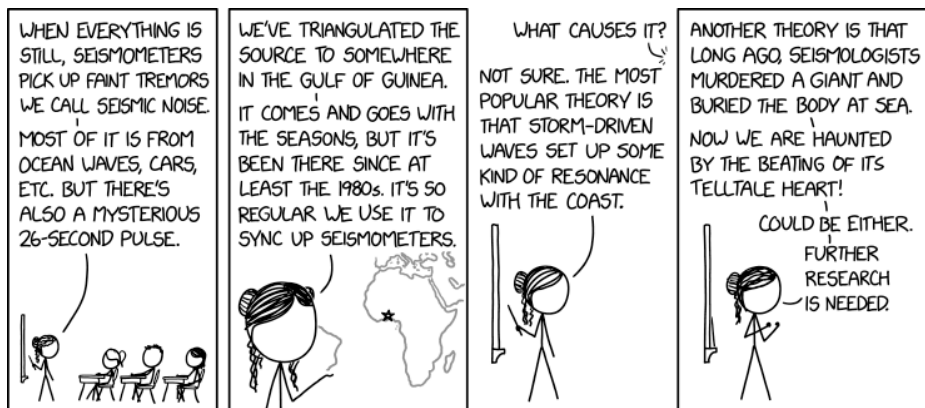
The title text refers to a treble clef, which is not a mathematical symbol but rather a musical symbol. The note of concern in the text suggests musical symbols may be viewed in such fights as exotic or especially dangerous. See also the last entry in the table below.

Here is a list of symbols and their explanation, from left to right (by rightmost edge) :

$\theta \ \emptyset \ \infty \ > \ \pi \ \partial \ + \ \neq \ \Psi \ \# \ \sim \ \Delta \ \zeta \ \Rightarrow \cdot \ \Gamma \ \rho \ \surd \rightarrow \int$   
 --

## #2344: 26-Second Pulse

August 10, 2020



There are some papers arguing that there's a volcanic component, but I personally think they're just feeling guilty and trying to cover the trail.

## Explanation

In this comic strip, Jill is presenting her project on geology to her classmates and is explaining some of the non-earthquake signals that seismometers detect. She describes a mysterious signal that repeats with a 26-second period. Scientists have exploited this signal to correct for clock drift in historic seismic records.

Jill initially provides a plausible explanation (some kind of natural wave pattern on the coastline of the Gulf of Guinea, which is in fact the most common theory about this signal). However, she quickly takes a turn for the dramatic when she claims that it might be a giant, murdered by seismologists, whose heart still beats. This is a reference to Edgar Allan Poe's short story *The Tell-Tale Heart*, in which the main character murders a man and hides his corpse beneath the floorboards, and then hears (or believes he hears) his victim's heart continuing to beat; the noise eventually drives him to confess his guilt to visiting police officers. (The narrator of *The Tell-Tale Heart* never uses that phrase in the story; he calls it a hideous heart.) "*The Tell-Tale Heart*" was previously referenced in 740: *The Tell-Tale Beat*.

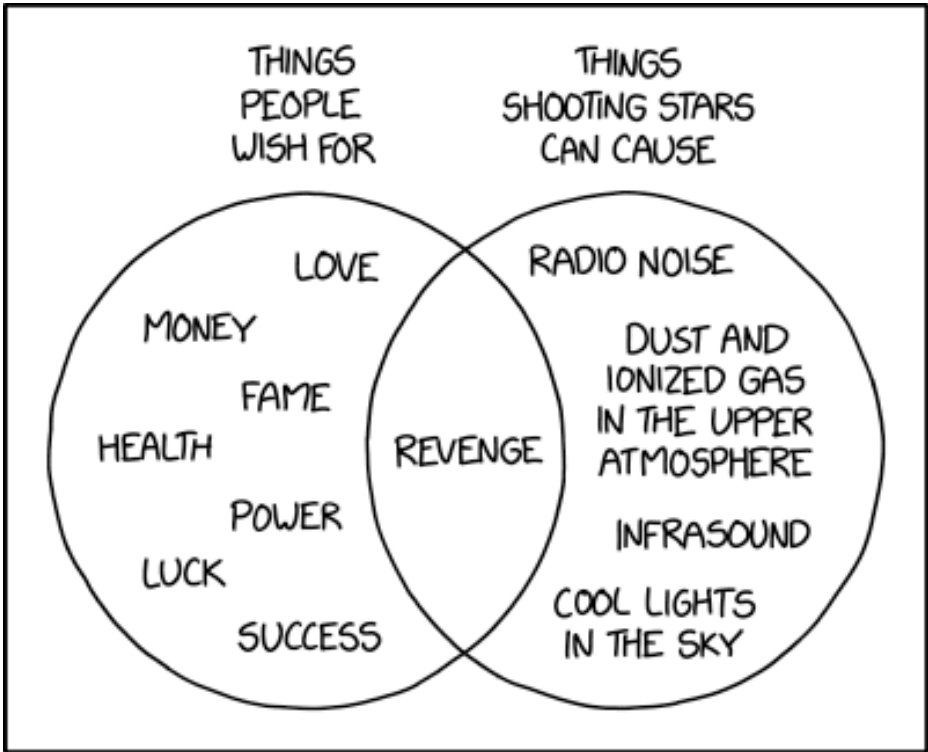
Normal human hearts beat much more rapidly than once every 26 seconds, but large animals and hibernating animals may have much slower heart rates (which would include a giant at the bottom of the ocean).[citation needed]

The title text gives an alternate explanation for the seismic activity: volcanic activity, but Jill continues to believe in the giant story. In the last panel she references the common science meme that further research is needed, which has been mentioned several times in previous strips, including 2268: Further Research is Needed.

A seismometer is a device for measuring vibrations in the earth's crust, and one is likely in the collection of Cueball from 2060: Hygrometer.

## #2345: Wish on a Shooting Star

*August 12, 2020*



Congratulations to whoever wished for revenge on a forest near the Tunguska River, a 1980 Chevy Malibu in Peekskill NY, Alabama resident Ann Hodges, every building in Chelyabinsk with glass windows, and the non-avian dinosaurs.

## Explanation

This comic was published at the annual peak of the Perseids meteor shower. It is a common practice to make a wish when one sees a shooting star, in hopes that the wish comes true. This comic consists of a Venn diagram showing what things are commonly wished for upon seeing a shooting star, and what things the shooting star may cause. Shooting stars, as they are actually meteors, can only cause changes to physical phenomena, such as radio noise or the appearance of the sky as they burn up in the upper atmosphere. The only thing that is shared between the potential wish side of the diagram and the shooting star caused side is revenge. This would occur when a shooting star actually hits the planet, becoming a meteorite. This is frequently highly destructive, given the high speed of falling meteors. As such, it would be possible for the meteorite to hit something that someone for some reason or another wished revenge upon. However, given the massive surface area of the planet, the likelihood that someone's revenge would be "granted" by a meteorite would be very low (although not quite as low as dunking a meteorite through a basket). The title text makes fun of this by detailing several incidents where a meteorite landed and caused damage.

List of things that were damaged by meteorites (from title text):

- On June 30, 1908 (Gregorian Calendar, Russia still used the Julian Calendar and was recorded there as June



17), an airburst caused by the breakup of a 100-meter falling meteorite or comet with the energy of some 30 megatons of TNT flattened some 80 million trees over 830 square miles (2,150 km<sup>2</sup>) of land in central Siberia near the Tunguska River. Due to the remoteness of the area, no people were confirmed dead in the incident.

- On October 9, 1992, a meteorite totaled a 1980 Chevrolet Malibu in Peekskill, New York.
- On November 30, 1954, a fragment of a meteorite passed through the roof of a house and struck a woman named Ann Hodges. She survived. Only two other people are known to have been hit by meteorites.
- On February 15, 2013, a meteorite exploded in an airburst over Chelyabinsk, Russia, creating a shockwave that shattered windows in the area.
- The extinction of the dinosaurs around 66 million years ago is believed to be caused by an impact of a comet or asteroid. Randall mentions "non-avian" dinosaurs, as birds are dinosaurs, though the general public not trained in science often doesn't realize this. No humans were alive to wish for the extinction of the dinosaurs,[citation needed] but perhaps the wish was made by some ancestral mouse-like mammal (or else wishes may violate causality).

If there is a "message" to this comic strip, it could be similar to those of 1024: Error Code and 2247: Weird Hill: that we shouldn't bother wishing for things that shooting stars can't give us, but should instead take time away from our temporal concerns and just relax and

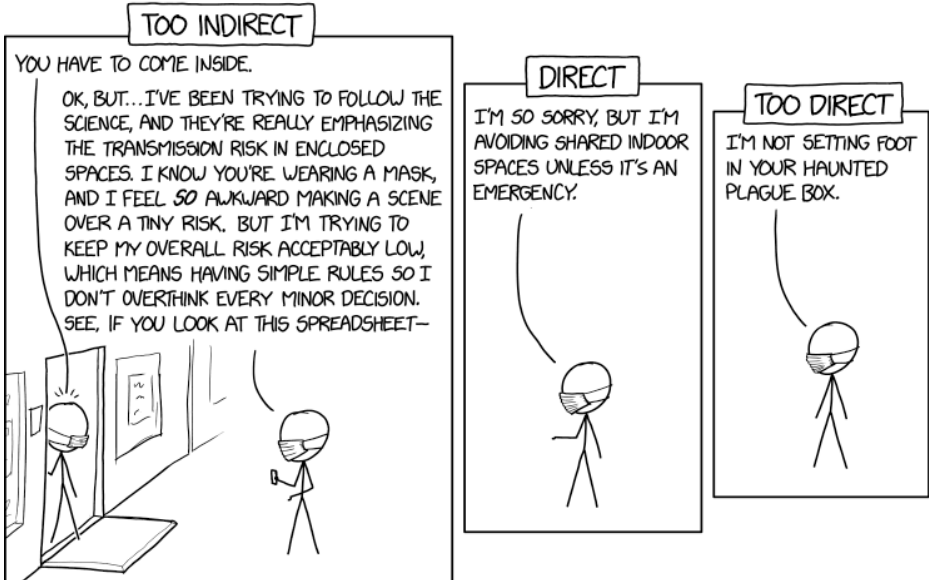
appreciate their beauty. Or maybe the message is that, if you must wish on a shooting star, you should wish for revenge, because that's something that might come true. Of course, as the title text makes clear, meteorites don't really land according to our designs and schedules, and if you're close enough to a shooting star to see it, and you wish for it to avenge you, and it is big enough to hurt someone, you're probably at risk yourself.

Meteorites were most recently mentioned in 2328: Space Basketball. Randall has discussed strange and "impossible" wishes in 1086: Eyelash Wish Log.

## #2346: COVID Risk Comfort Zone

August 14, 2020

WAYS TO SAY NO WHEN SOMEONE TELLS YOU TO DO SOMETHING OUTSIDE YOUR COVID RISK COMFORT ZONE:



I'm like a vampire, except I'm not crossing that threshold even if you invite me.

## Explanation

This comic is another comic in a series of comics related to the COVID-19 pandemic.

One of the major vectors for transmission of SARS-CoV-2 is in sharing an enclosed space with someone who is infected, especially someone who is asymptomatic and not aware of being infected. Wearing a face mask, as both "Inside Cueball" and "Outside Cueball" are, will dramatically reduce the rate of transmission, perhaps by a factor of 30 compared to the "baseline" of neither wearing a mask, but given the limited volume of air available, it is likely that sooner or later one of them will inhale enough air with enough virus-bearing droplets to risk catching the disease. This knowledge leads Outside Cueball to refuse Inside Cueball's invitation to visit indoors, but (in a recurring theme of xkcd) leaves him feeling uncertain as to how he should refuse the invitation. The comic proceeds to depict a spectrum of options.

The first option is overly technical to the extreme, to the point where Outside Cueball is effectively giving Inside Cueball an in-depth lesson on common health advice during the 2020 COVID-19 pandemic. Being overly technical is a common trope among xkcd comics -- in particular, Outside Cueball's fervent insistence that he made a spreadsheet so he doesn't "overthink every minor decision" is disproved by (a) the fact that he made a spreadsheet (cf. 1445: Efficiency) and (b) the events of

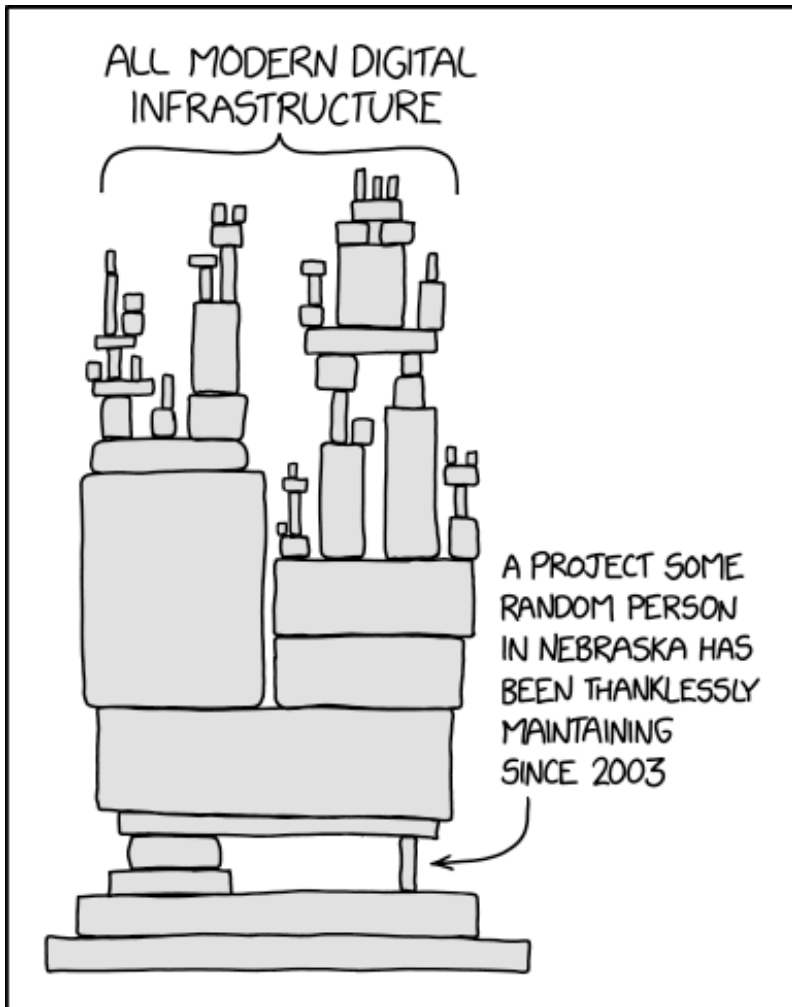
2330: Acceptable Risk. The second option that is presented is the most reasonable of the three, being an expression of reasonable concern, and a polite refusal to enter. The last option is simplified to the extreme, and successfully insults the owner of the building while still expressing a desire to avoid coming inside. The title text appears to be a continuation of the last panel. In it, someone, presumably Cueball, compares themselves to a vampire, because folklore has it that vampires cannot enter a building without permission. However, the speaker has no interest in coming inside, despite any invitations that they may have, whereas vampires usually want to come inside to drain the occupants' blood. Some vampires will even take measures to trick an invitation out of a hesitant "host", which is something that would be unthinkable to Outside Cueball under the COVID circumstances.

As a fourth option compromise between the second and third choices, Cueball could just flatly refuse: "No," or "No, thank you." We don't know the circumstances here (is Inside Cueball a friend of Outside Cueball, a shopkeeper, or just a passing acquaintance?), but clearly there's no urgent reason that Outside Cueball has to go inside, and so he doesn't owe Inside Cueball any explanation (nor any insults).

Other comics mentioning "COVID-19 risk" include 2330: Acceptable Risk and 2333: COVID Risk Chart (which might itself be the spreadsheet made or used by Outside Cueball).

## #2347: Dependency

*August 17, 2020*



Someday ImageMagick will finally break for good and we'll have a long period of scrambling as we try to reassemble civilization from the rubble.

## Explanation

Technology architecture is often illustrated by a stack diagram, in which higher levels of rectangles indicate components that are dependent on components in lower levels. This is analogous to a physical tower of blocks, in which higher blocks rest on lower blocks. The stack in this cartoon bears a striking resemblance to a physical block tower, suggesting the danger that the tower will lose its balance when a critical piece is removed, in this case a piece near the bottom, labeled as being maintained by a single semi-anonymous person located somewhere relatively unimportant doing it for their own unknown reasons without fame or acknowledgement. The concept of balance is not intended to be communicated by a stack diagram, making this a humorously absurd extension of a well-known diagram style.

ImageMagick, mentioned in the title text, is a popular, standalone utility released in 1990 that is used for performing transformations between various graphics file formats, and various other transformations. While there are also numerous libraries and APIs for performing these tasks within larger programs, ImageMagick is so popular and easy to use that many programs use its API or just find it easier to shell out to ImageMagick to perform a necessary transformation. They therefore depend on ImageMagick, and would break if ImageMagick were to disappear.

## Background and Examples[edit]

Taking code re-usability and modularization to its logical extreme has been a long-time tenet for programmers; programming began as a slow task on very memory-constrained systems, utilizing punch cards and days of delay waiting to discover a bug, so that reuse made things possible that otherwise wouldn't be. Once systems became small, fast, and able to hold a lot of data, the ability to provide higher and higher degrees of automation made reusable libraries a huge engine behind the development of technology. By outsourcing what would seem like basic functions, such as string manipulation, to other libraries, developers waste less time reinventing the wheel, so the philosophy goes (or as Beret Guy's business practices literally: 2140: Reinvent the Wheel), and thus many tiny packages, many of which contained only one function, became popular dependencies. This was especially true in Unix and Linux, where an entire program is commonly used for one small task, and programs exist to tie others together into powerful shell scripts.

Node.js (a platform for JavaScript) and Python are two modern ecosystems providing huge stashes of centralized libraries where developers of the world can come together to stand on the shoulders of all the small useful libraries they make for each other, to make new ones that are more and more powerful, and also more and more prone to sudden new unexpected bugs somewhere in the dependency chain. JavaScript was designed to be an easy to use front end scripting language, not a basic and core backend language as users of node.js's NPM package manager have made it be. While in theory, such a system may sound good for developers who would need to write and maintain fewer lines of code, systems which are highly optimized are also highly susceptible to rapid changes. For example, the famous left-pad



incident in the NPM package manager left many major and minor web services which depended on it unable to build. A disgruntled developer unpublishing 11 lines of code was able to break everybody's build, because everyone was using it.

In 2014, the Heartbleed bug revealed a significant portion of the internet was vulnerable to attack due to a bug in OpenSSL, a free and open-source library facilitating secure communication. One headline at the time demonstrated this comic in real life: "The Internet is Being Protected by Two Guys Named Steve". The aforementioned Steves were overworked, underfunded, and largely unknown volunteers whose efforts nevertheless underpinned the security of major websites throughout the world. Randall provided a concise, helpful explanation of the bug in 1354: Heartbleed Explanation.

In 2020, the sole maintainer of the library core-js, used by 75% of the top 100 websites to polyfill in new JavaScript features for old browsers and depended on by tons of popular libraries such as Babel, ran over two dark-clothed drunk pedestrians, one of whom was laying down, at night in Russia while speeding in front of a crossing. He had quit previous jobs to be able to maintain core-js, resulting in not having enough money to settle, and he was sentenced to 18 months in an open prison ("колония-поселение").

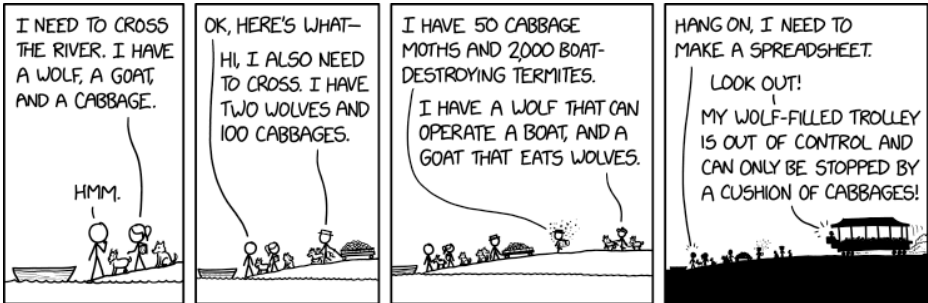
Leading up to 2024, a user account going by the name Jia Tan gained the trust of xz's (one and only) maintainer. Over the course of 3 years, Jia Tan cleverly inserted a patch into xz that allows a remote user to gain root-level access via the common ssh protocol. This compromised version of xz was released in March 2024. Another programmer, Andres Freund, found this

backdoor before xz was widely distributed.

The current model of libraries and open-source development (topics which Randall has addressed extensively in the past) relies heavily on the free and continued dedication of unpaid hobbyists. Though some major projects such as Linux may be able to garner enough attention to build an organization, many smaller projects, which are in turn reused by larger projects, may only be maintained by one person, either the founder or another who has taken the torch. Maintaining libraries requires both extensive knowledge of the library itself as well as any use cases and the broader community around it, which usually is suited for maintainers who have spent years at the task, and thus cannot be easily replaced. Thus, there are many abandoned projects on the internet as people move on to greener pastures. Far from the days of backwards compatibility, that's usually not a problem, unless a project happens to be far up the dependency chain, as illustrated, in which case there may be a crisis down the road for both the developers and the users down the chain.

## #2348: Boat Puzzle

August 19, 2020



'No, my cabbage moths have already started laying eggs in them! Send the trolley into the river!' 'No, the sailing wolf will steal the boat to rescue them!'

## Explanation

This comic is a twist on an old riddle. In the original riddle, a person has to cross a river in a boat that can only hold them and one other object. They have a wolf, a goat, and a cabbage that they need to bring across with them, similar to the first panel. If the wolf is left alone with the goat, however, the wolf will eat the goat; and if the goat and cabbage are alone, the goat will eat the cabbage. (The problem can be solved in seven trips.)

However, the comic quickly devolves into surrealism in the later panels as new characters show up, bringing deviations of the original "cabbage", "goat", and "wolf" that add extra layers of complexity to the riddle. White Hat brings extra wolves and cabbages. Black Hat, in his traditional classhole style, brings cabbage moths which will infest unsupervised cabbages with destructive larvae, and boat-destroying termites. How he intends to bring them across the river (or even if he wants to) is unknown, but it brings to mind the parable of The Scorpion and the Frog. Beret Guy arrives with a wolf who can operate a boat, who could perhaps serve as a second pilot to expedite the crossing, so long as he is not asked to ferry a goat, and also a goat who eats wolves, possibly in addition to the cabbages. This is unusual[citation needed], as one would expect from Beret Guy's associates.

The last panel is a reference to the Trolley Problem, a moral test that asks the participant whether they would

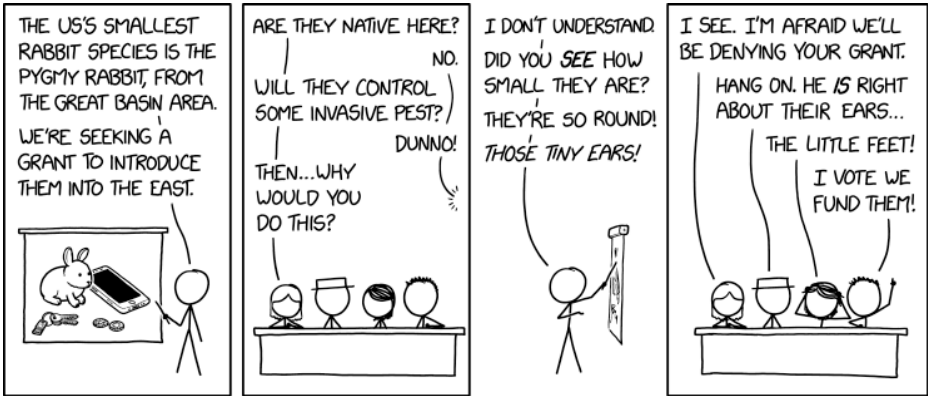
passively let people in the way of an uncontrollable trolley die or actively divert the trolley to kill a single person standing on a branch of the tracks. The comic gives a twist here too: according to the title text, the characters must choose between stopping the trolley full of wolves with a cushion of cabbages (in which Black Hat's cabbage moths have laid eggs, which he implicitly argues are morally equivalent to "innocent children") or letting it crash into the river (at which point the wolf who can operate a boat will steal the boat to rescue the wolves from the trolley, which will delay the other characters from crossing the river).

The River Crossing puzzle was also mentioned in 1134: Logic Boat and referenced in 589: Designated Drivers and 2684: Road Space Comparison.

The Trolley Problem was also mentioned in 1455: Trolley Problem and referenced in 1938: Meltdown and Spectre.

## #2349: Rabbit Introduction

August 21, 2020



Washington state is seeing great success with reintroducing the Columbia River Basin subpopulation. We cannot allow them to further widen the interstate bun gap.

## Explanation

Cueball is giving a presentation on the pygmy rabbit to a group of panelists, requesting a grant to introduce the species to the eastern United States. The head of the panel, Blondie, asks about typical reasons for introducing a species. If they were native to an area, but had been locally depopulated, re-introduction can help to restore the local ecosystem, but Cueball admits this is not the case. Another reason animal populations may be introduced is to control a local pest. Cueball seems to have no idea what the impact on the local ecosystem would be. In fact, he makes quite clear that his reasoning is simply that the creatures are tiny and cute, and he wants to spread them. He also appears to be entirely perplexed that the panel doesn't feel the same way.

Blondie, very reasonably, immediately moves to deny the request. Not only would such a grant expend funds for no legitimate scientific or ecological purpose, but it would risk serious and unstudied impacts on the local ecosystem (especially considering that this very thing has happened with rabbits before). However, at this point, the other three panelists - White Hat, Megan and Hairy - have been swayed by Cueball's unconventional argument. All three of them are visibly entranced by the cuteness of the rabbits, and appear willing to fund the request purely based on affection for the animals. This is sort of the opposite of the "charismatic megafauna" method of conservation - charismatic minifauna: the more mini, the more charismatic.

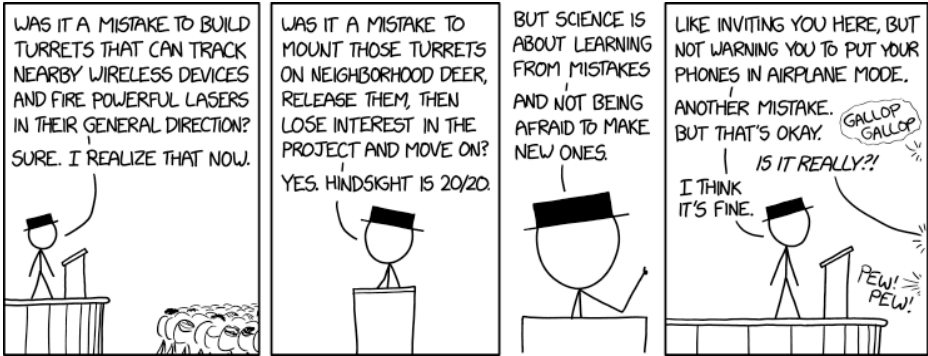
The title text mentions the effort to reintroduce the Columbia Basin pygmy rabbit into their native area of the Columbia River drainage basin. It refers to an "Interstate Bun Gap", suggesting a competition between states over which has the most and/or cutest rabbits. That phrase is a *reductio ad absurdum* of other gaps in capabilities between states and nations, such as the bomber gap and missile gap (widely-publicized shortages - later revealed to be fictional - of the respective nuclear arsenals of the United States compared to the Soviet Union), perhaps similar to the satirical "mine shaft gap" from the 1964 film *Dr. Strangelove*.

This comic continues an *xkcd* tradition of dealing with the subjective cuteness of rabbits as a scientific discipline (1682: Bun). Randall seems fascinated with the cuteness of lagomorphs, as it is a recurring subject.



## #2350: Deer Turrets

August 24, 2020



When my great grandfather designed the Titanic and it hit an iceberg and sank, he didn't sit around moping. He took those lessons to his next job designing airships, and he made the Hindenburg completely iceberg-proof!

## Explanation

In this comic Black Hat is giving what appears to be a press conference, in which he's offering a non-apology for his recent actions. This is not uncommon in politics and the military, in which the speaker offers bland admissions, such as "mistakes were made", while minimizing the importance of whatever happened.

In true Black Hat fashion, he has apparently built laser turrets that automatically shoot at nearby wireless devices. This could potentially be useful in a military context, but for reasons unforeseeable, he's mounted them on local deer. This not only releases dangerous and indiscriminate weapons, potentially into populated areas, but also makes those weapons very difficult to identify and recover or shut down. Moreover, he then apparently lost interest in the whole project, presumably making no attempt to contain the damage.

Throughout the exchange, Black Hat shows a typical lack of concern for the consequences of his action, dismissing them as "mistakes", even though they were clearly deliberate actions with very predictable outcomes. He then says that it was also a mistake to invite everyone present without warning them to put their phones in airplane mode, heavily implying that the laser-deer are approaching, and everyone on the audience is in immediate danger.

The title, "Deer Turrets," may be a pun on "deterrents,"

as laser turrets would certainly deter people with wireless devices from approaching deer.

In the second panel Black Hat uses the common idiom "hindsight is 20/20". This may be a pun, as "hind" is a term for an adult female (doe) deer - as a counterpoint to the adult male (buck) deer being known as a "stag" - and a "sight" is a visual aligning device, often for weaponry. Whether or not the potential pun has any further caliber to its references, this might be the ultimate aim of this wording.

The auto-targeting laser turrets may be a reference to attempts by researchers at the University of Washington to create a laser-based battery charging device . The device in question is mounted on a turret that locates and aims the beam at a photovoltaic cell attached to the battery. The same technology could theoretically be used with a higher-powered laser, but for the application described in the comic, the targeting mechanism would need to be altered to sense any electronic rather than the accompanying photovoltaic cell.

In the title text, Black Hat claims that his great grandfather designed the RMS Titanic, the then-largest ocean-liner in the world which sank after striking an iceberg in 1912, and the LZ 129 Hindenburg, the then-largest airship in the world which caught fire and crashed in 1937. He claims that his ancestor did not retire from the design business after the loss of the Titanic, but instead learned from it and made the Hindenburg "iceberg-proof". This is an obvious and humorous lie for

several reasons. First, the lead designers of the Olympic-class Titanic and the Hindenburg-class airship were two different people, Lord Pirrie and Dr. Ludwig Dürer respectively, and Black Hat is probably not one of Dürer's great-grandsons (Lord Pirrie had no children). Secondly, while no airship has been recorded to be destroyed by striking an iceberg, it's not because of any "iceberg-proofing" efforts by Black Hat's great-grandfather, or anyone else -- it's just due to the basic fact that airships fly in the air, where there are no icebergs.[citation needed] Were an airship to strike an iceberg, it would almost certainly be destroyed; in fact, the even deadlier accident on the airship USS Akron resulted from the airship simply striking the (unfrozen) ocean.












There is also the implication that the "iceberg proofing" is where the project went awry - a hot enough fire will melt an iceberg, so it may be implied that the "iceberg proofing" was intentionally filling the airship with flammable hydrogen gas so it would explode and melt the iceberg on impact. It is unclear how this would be remotely helpful in case of iceberg collision, but it would be very ironic given the fate of the Hindenburg.

The possibility of mounting devices on wild deer was previously referenced in the title text of 1924: Solar Panels.

Black Hat has built a similar device to target users of Google Glass in 1251: Anti-Glass.

## #2351: Standard Model Changes

August 26, 2020

CHANGES I WOULD MAKE TO THE STANDARD MODEL					
CONSISTENT QUARK NAMES (USE "STRANGE" AND "CHARM" FOR BOSONS)					
U UP	 (LEFT)	t TOP	g GLUON	 VIN DIESEL	WITH ALL RESPECT TO PETER H, THE HIGGS BOSON NEEDS A FLASHIER NAME
d DOWN	 (RIGHT)	b BOTTOM	$\gamma$ PHOTON	 GRAVITON	LET'S JUST INCLUDE IT, IT'S PROBABLY FINE
e ELECTRON	$\mu$ MUON	NO ONE NEEDS TAU LEPTONS 		 STRANGE BOSON	DECOY PARTICLE FOR PEOPLE MAKING NONSENSE CLAIMS ABOUT "QUANTUM" PHILOSOPHY STUFF
 ELECTRON NEUTRINO	TOO MANY NEUTRINOS 	 DARK MATTER	 CHARM BOSON	 COOL BUGS	VERY SMALL BUGS ARE FUNDAMENTAL PARTICLES NOW
FIX NEUTRINO SYMBOL SO I STOP MIXING UP $\nu$ AND $\bar{\nu}$ WE FOUND IT!					

Bugs are spin  $1/2$  particles, unless it's particularly windy.

## Explanation

In this comic, Randall proposes some changes to the Standard Model of particle physics. The currently accepted particle table has 17 slots: 12 fermions (first 3 columns of the table - six quarks [top two rows] and six leptons [bottom two rows]) and five bosons (last two columns of the table - four-gauge bosons [left hand column] and one scalar boson [right hand column]). This is another comic containing red annotations over a complex and established structure.

While the Standard Model's predictions are very well supported by experiments, the physics community has identified several flaws in it (e.g. it lacks any particles to convey gravity), and so lots of research is committed to searching for "Physics beyond the Standard Model". Some of Randall's changes are sort of intended to fill some of those gaps, but for the most part they are nonsensical (although not quite as much as the Turtle Sandwich Standard Model or Fixion).

### Quarks[edit]

Randall's proposed changes to the quarks are relatively restrained -- he proposes only that the "strange" and "charm" names should be moved to bosons, while the strange quark should be renamed the "right quark" and the charm quark should be renamed the "left quark", so that all quarks will have "ordinary" directional names.

In reality, the original quark model proposed by Murray Gell-Mann included only three quarks, with the "strange" quark

so named because the particles that contained them were strangely long-lived relative to their masses. The "charm" quark was so named when it was proposed because it brought a "charming" symmetry to the weak interaction, which we now understand is because it completes the second generation of quarks, along with the strange quark. When a third generation of quarks was proposed, they were called top and bottom by analogy to the up and down quarks (which are so named because of the isospin they carry), though the names 'truth' and 'beauty' were briefly in competition, and colliders working with B quarks are sometimes even now called "Beauty Factories".

Randall likely applied "left" to "charm" and "right" to "strange" simply due to the placement of the particles in the table: In the American English vernacular, the phrase "left and right" is more common than "right and left", in the same way that "top and bottom" is more common than "bottom and top", and "up and down" is more common than "down and up". So he placed "left" above "right" to match the ordering of the other quark generations.

## Leptons[edit]

While Randall leaves two leptons, the electron and the muon, untouched, he has opted to discard the tau lepton entirely. Each of these three leptons has an associated neutrino; Randall has decided to discard all but the electron neutrino, as he has decided that three are too many neutrino types. He has also replaced the standard symbol for the neutrino, the Greek letter  $\nu$  (nu), with a capital N, in order to avoid confusion between  $\nu$  and v, the two letters appearing similar, though this might further be confused with nucleon (particle physicists commonly use N to denote

"proton or neutron", and excited states of nucleons are given the symbol N, followed by the mass in parenthesis) or possibly even with the symbol for Nitrogen (the atomic nucleus with 7 protons and a similar number of neutrons, encountered more in radiology/chemistry as an N,  ${}^7\text{N}$ ,  ${}^{14}\text{N}$ ,  $\text{N}^+$ ,  $\text{N}_2$  and other variations).

In place of one of the neutrinos, Randall has introduced a new elementary particle that supposedly explains the existence of dark matter. The nature of dark matter is one of the most famous mysteries in physics: galaxies seem to have much higher gravity than their detectable matter would account for, yet this mysterious form of matter does not seem to interact with other matter in any other detectable way. Neutrinos are known for rarely interacting with other matter, due to their lack of charge, which could justify Randall's decision, but even the little interaction that neutrinos have with the weak force rules them out as candidates for dark matter. Hypothetical sterile neutrinos could be the source of dark matter, and also for the small but nonzero masses of the familiar neutrinos, but no such particles have yet been identified. Together with the arrow, the only one in the comic that points at the particle's box rather than the symbol, the triumphant exclamation "We found it!" probably means that the new "dark matter" entry in the table is the dark matter particle.

## **Bosons[edit]**

Randall proposes several new names for existing particles. First, that the W and Z bosons should be renamed to the charm and strange bosons, respectively (taking the names from the quarks), and second, that the Higgs boson should be named the Vin Diesel boson, as he considers Peter Higgs's name to be too boring to be



given to a particle. The Higgs boson is known in the popular press (to the chagrin of many physicists, including Higgs) as "The God Particle", which is certainly a flashy name, but which itself was changed by the editors of the book of the same name from its authors' originally-intended title: The Goddamn Particle.

Randall inserts the graviton, a purely theoretical particle, noting that its inclusion is "probably fine". While the graviton has never been observed, it is occasionally included in diagrams of the standard model to show its hypothetical place, which likely convinced Randall to do the same. Here it is shown below the Higgs boson, implying to be a scalar boson, though it is theoretically a 2nd-order tensor boson (with a spin of 2) and is usually given its own column.

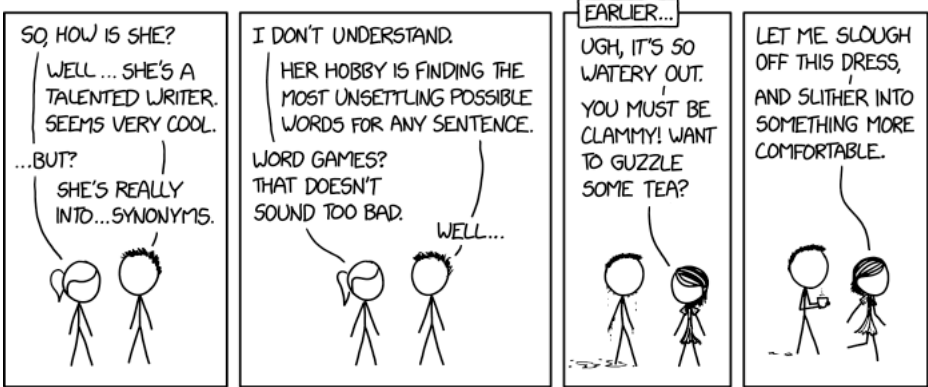
Randall also proposes that a false decoy "Magic" particle should be added to the Standard Model, to trip up promoters of quantum mysticism. Presumably, anyone who invokes this particle to support their claims will expose themselves as a fraud, much as cartographers will print trap streets on their maps to catch plagiarism.

Finally, Randall adds "Cool bugs" as a fundamental particle, with an explanation of "Very small bugs are fundamental particles now". In reality, a typical ladybug contains about 23 sextillion quarks and electrons.

The title text builds on the "Cool bugs" entry, joking about what spin bugs would have if they were a fundamental particle. Having a  $1/2$  spin unless it's windy may suggest that bugs may be resistant to air flow around them until it reaches a high velocity.

## #2352: Synonym Date

August 28, 2020



We need some grub to munch--I'll go slouch over to the kitchen.

## Explanation

Ponytail asks Hairy about Megan, his date. Hairy mentions that she's a talented writer and seems cool, but when prompted by Ponytail, says Megan is into synonyms. Megan apparently enjoys unsettling Hairy with words. Ponytail thinks word games aren't too bad, and she would be right if it weren't for Megan's unsettling use of them.

In the next panel (labeled "Earlier..."), it's raining (or humid), and Hairy comes back in. Megan comments, "Ugh, it's so watery out. You must be clammy! Want to guzzle some tea?" replacing wet (or humid), cold (or sweaty), and drink with more suggestive, possibly-repulsive-sounding words. "Clammy" does technically refer to having damp skin, but it is usually used in the context of nervousness or illness, and "guzzle" suggests very rapid consumption, which is not a safe way of drinking hot tea, and is also considered rude when enjoying a meal with others, especially romantic interests. Continuing, she says, "Let me slough off this dress, and slither into something more comfortable," replacing take (or remove, or disrobe) and slip. This last sentence of course strongly suggests snakes shedding their skin. Serpentine movements are sometimes regarded as alluring and attractive, but people usually don't favorably compare their clothing to snakes' skin care.[citation needed]

She further elaborates on this in the title text, saying "We

need some grub to munch -- I'll go slouch over to the kitchen." By using the word "grub," she presumably means the slang term for basic food like the type served in pubs (which is often greasy fast-food, served in a dirty -- one might even say grubby -- environment), though it may also invoke the image of white insect larvae, like pale lumps of flesh squirming in a dark hole, while "slouching" has connotations of laziness or suspicious activity, rather than romance.

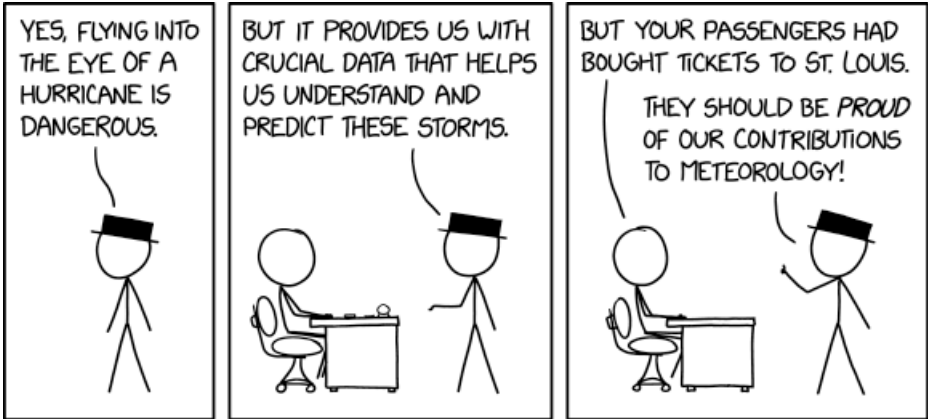
Excessive use of uncommon words is a common trope in fiction, and also seen in real life. Usually, the speaker is trying to demonstrate their superior intelligence or knowledge. Megan, on the other hand, seeks to use a similar tactic to make listeners uncomfortable. The words she's using aren't especially complex or uncommon, and they're technically correct, but they've been selected to evoke disgust in the listener.

Strange synonyms were also the focus in 1322: Winter, and a similar concept was the joke in 919: Tween Bromance (although in that strip, Cueball was making Megan uncomfortable). Megan has previously shown off her love of uncomfortable puns ("Vore of the Roses") in 2245: Edible Arrangements.

Randall has written many comic strips before about his (comical, fictional) hobbies, but this is the first time he's written about someone else's hobby.

## #2353: Hurricane Hunters

*August 31, 2020*



Our flight gathered valuable data on whether a commercial airliner in the eye of a hurricane can do a loop.

## Explanation

The comic strip opens with Black Hat explaining to Cueball (who is presumed to be some government official) that flying into hurricanes, while risky, provides valuable scientific data. Although the eye itself is relatively calm, it is surrounded by the eyewall, a region of extremely intense thunderstorms. Thus, the danger of flying through such storms must be carefully weighed against the scientific knowledge being gained. In the real world, such missions are conducted by highly-trained pilots with specialized aircraft, such as the NOAA Hurricane Hunters and the US Air Force's 53rd Weather Reconnaissance Squadron (also nicknamed "Hurricane Hunters").

However, Cueball's comment in the third panel shows that Black Hat is not discussing the activity of hurricane hunting in general, but rather is attempting to justify his decision to fly a passenger jet through the eye of a hurricane. Passenger airliners are not meant to fly into hurricanes, and can easily crash there, although it is possible to go through one without significant damage. It's not clear if Black Hat is (somehow) a jet pilot himself, has come into ownership of an airline and was merely directing a flight, or, probably most likely, simply hijacked the flight he happened to be on, but the commercial jet passengers were not expecting to "participate" in a hurricane hunting mission. Black Hat replies that, instead of being upset, the passengers should be proud of their contributions to meteorology, but their

contribution is probably negligible, as they were not actively collecting useful scientific data.

This comic is likely referencing both Hurricane Laura, which was active during the week prior to this comic strip's publication, and Microsoft Flight Simulator 2020, which players have been utilising the software's ability to simulate real-time weather to fly into and explore the (virtual) aforementioned hurricane. At the time the comic was released, the simulator only had passenger aircraft available to pilot, echoing Black Hat's flying of a commercial jet into a hurricane. A similar situation where historical/well-documented experimental techniques are used in inappropriate situations occurs in 1594: Human Subjects, albeit by test subjects rather than "researchers", if Black Hat can be called that.

In the title text, Black Hat says that their flight gathered data on "whether a commercial airliner... can do a loop. This could imply that he did not, as he "gathered data" not "Demonstrated" (E.g. "I gathered data on whether a rocket could hit the sun"). Alternatively, this could imply that he did do it, and that his gathering data was attempting it (E.g. "I gathered data on whether I could jump 50cm").

The Boeing 707 was made to successfully execute a barrel roll and fly inverted during a 1955 test flight. If no flight envelope protections are active, barrel rolls are possible with any aircraft and any helicopter, because the aircraft and its fuel systems only experience mild and positive g loads, never negative ones. Likewise, the air flow stays the

same as in level flight. Problematic is ending the barrel roll, as there is a possibility of exceeding the safe speed limits.

Another passenger jet that was barrel-rolled is the Concorde. Pilots Brian Walpole and Jean Franchi did on a test flight - not once, but several times.

Loops are a lot more problematic because of the speeds reached when ending the maneuver, and the speed needed to begin it. But like the barrel roll, a loop can be flown while only experiencing mild and positive g loads. In fact, Harold E. Thompson flew several loopings in a Sikorsky S-52, a helicopter first flown in 1947. Prolonged inverted flights, though, cause negative g forces, an altered air flow, and cause havoc with the fuel systems, parts of which are gravity-driven. Aircraft that can fly inverted for longer than a few seconds are specifically designed, for example aerobatic aircraft and fighter jets.

It is possible that this is his justification of why the flight contributed to meteorology. However, passenger airliners' abilities to do loops has nothing to do with that field of science. Moreover, the same data could be gathered by flying the same airliner without passengers, or with willing ones.



## #2354: Stellar Evolution

*September 02, 2020*

AFTER A STAR BEGINS FUSING HYDROGEN, IT  
MAY REACH A STABLE EQUILIBRIUM IN WHICH  
IT SEPARATES FROM MASSACHUSETTS AND  
DEVELOPS A THRIVING LOBSTER INDUSTRY.  
THIS IS KNOWN AS THE MAINE SEQUENCE.



It may remain in equilibrium for some time, slowly growing, and then suddenly become significantly redder.

## Explanation

This is a pun on the main sequence, the continuous and distinctive band of stars that appear on Hertzsprung–Russell diagrams. Stars on this band are known as main-sequence stars. These are the most numerous stars in the universe, and include the Earth's Sun. The main sequence forms a major part of a star's life cycle, with smaller stars spending more time on it, where they transform hydrogen to helium via nuclear fusion to generate energy and sustain themselves.

Miss Lenhart starts off apparently describing the main sequence. However, she veers off into the history of Maine, the most northeastern of the 48 contiguous US states. She mentions the separation of Maine from Massachusetts and its lobster fishing industry, similar to how, soon after the beginning of their lifespans, stars evolve from early stages (like T-Tauri stars) and go onto the main sequence, where they become stable and stay for a long time. She makes a play between "main" and the U.S. state of "Maine", which are homophones. The allusion to stars might also be a reference to the representation of individual states as stars on the canton of the US flag.

## Title text[edit]

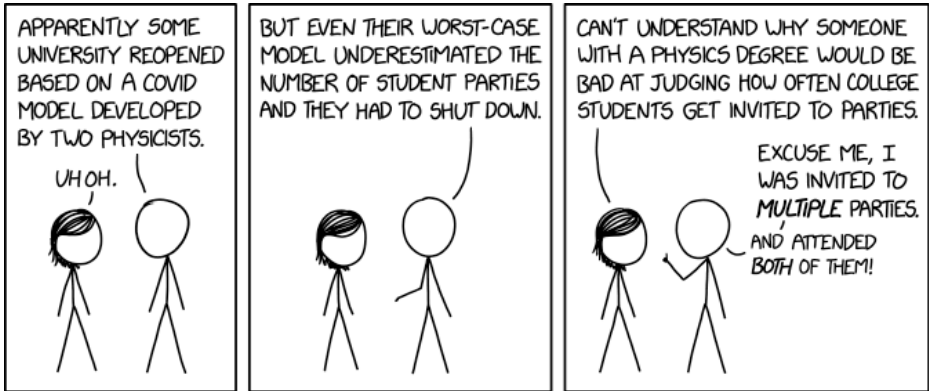
The title text puns on either the state or the star slowly growing for a long time, before suddenly becoming "redder". In the case of the state, the population of Maine has been slowly but steadily growing over the last century, increasing from about 700,000 in

1900 to about 1,350,000 in 2020. Similarly, stars with a mass of 0.6–10  $M_{\odot}$  slowly grow while they are on the main sequence, then increase in size and leave the main sequence in the subgiant phase, before suddenly becoming red giants.

In American politics, "red" most recently refers to the Republican party (NBC showed Republicans in blue and Democrats in red until 1996, and CNN until 1992). While in the past Maine has frequently voted for Democratic party candidates, Republican party candidates have increasingly won more campaigns or lost campaigns with larger minorities of the vote. For instance, Maine, which has used a district-based voting system, voted in its entirety for the Democratic party presidential candidates in the 1992, 1996, 2000, 2004, 2008, and 2012 presidential elections, but one of its districts voted for Republican candidate Donald Trump in 2016 and 2020. Meanwhile, a main sequence star transitions eventually into a red giant, also becoming "redder". Alternatively, the color change could refer to lobsters; when one is cooked, it turns from a bluish-green to a bright red-orange. "Red" is unfortunately also used in the derogatory terms "rednecks" for rural lower income folks (Maine is a predominantly rural, lower income state), and "redskins" for indigenous Native Americans (discussion of indigenous empowerment has been rising in Maine).

## #2355: University COVID Model

*September 04, 2020*



I admit this is an exaggeration, since I can think of at least three parties I attended while doing my degree, and I'm probably forgetting several more.

## Explanation

This comic is another in a series of comics related to the COVID-19 pandemic.

Cueball begins telling Megan an anecdote about how a college decided to reopen "based on a COVID model developed by two physicists." (The incident in question is likely a reference to this article and tweet about the University of Illinois, that went viral with similar wording the day before the comic was published). Presumably, the model predicted that the university could allow students to return to campus while still keeping cases of COVID-19 under control, perhaps using some combination of reduced classroom and residence hall density, and by implementing policies against large social gatherings.

Before he can get further, Megan interrupts him with "Uh oh," perhaps worried that an epidemiological model created by people who aren't epidemiologists could be ineffective. Alternately, she may be expressing concern specifically about physicists' epidemiological modelling. Cueball then confirms her fears by saying that the model underestimated how many parties the students would hold, and so the actual number of cases on campus has turned out to be greater than even their worst-case prediction. Megan facetiously wonders how a physicist could have failed to know how much college kids party, implying that physicists do not attend many parties. Cueball, representing Randall, a physics major, then

retorts that he "was invited to multiple parties! And attended both of them!" implying first that he was invited to many parties over an undefined period of time at college, but then admitting it was only two.

In the title text, Randall, no longer in-character, admits to attending at least a third party, and possibly a few more that have been forgotten, and confirms this was over the entire course of his degree studies, likely 4-8 years or more. This demonstrates, as an introverted physics major who struggles with social interactions,

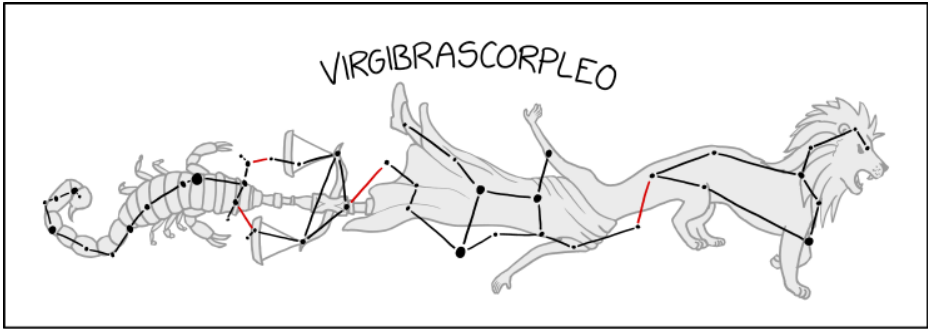
he (and by implied extension most Physics majors) has little interest in attending parties. As many other people go to college for the parties rather than the education[actual citation needed], we can only imagine how severely his campus epidemiology model would underestimate the number of opportunities for the coronavirus to spread.

A nontrivial number of colleges followed this trajectory in 2020, such as the aforementioned University of Illinois at Urbana-Champaign.

A different comic with physicists modeling another field is 793: Physicists.

## #2356: Constellation Monstrosity

*September 07, 2020*



I GOT KICKED OUT OF THE INTERNATIONAL ASTRONOMICAL UNION FOR ADDING  
EXTRA LINES BETWEEN THE CONSTELLATIONS TO CREATE A MONSTROSITY.

It's rare to get both astronomers and astrologers equally mad at you, but apparently I've messed up both a bunch of star location databases **AND** the will of the fates.

## Explanation

Constellations in the night sky are formed by pattern-forming various asterisms and other stellar relationships in the night sky. Being rather subjective, different cultures have inculcated differences in their interpretations, some subtle and others less so, for the exact same objective views of the night sky. Even where the same groupings are recognised, distinct cultures can 'see' different forms behind that group of stars. However, observers in the southern hemisphere will see entirely new constellations not visible to those in the northern one, and vice-versa, whilst observing those patterns fully visible to both (on the ecliptic) as inverted and therefore may inspire vastly different conceptualised images or even connectivities. The International Astronomical Union has demarcated the sky into 88 constellations, mostly those known to ancient Greece (catalogued by Ptolemy) plus southern constellations designated by astronomers during the European Renaissance.

Randall has taken one particular zodiac (or at least part of the hellenic one, closely tied to western astrology and still inspiring astronomical naming) and imagined further lines connecting stars to link up four separate constellations, to create a portmanteau constellation with a portmanteau name. In fact, this connection is half true, since Libra used to be the two claws of a much larger Scorpio, the larger constellation having been split in two when the twelve zodiac signs were set as they are now.



The four constellations used here are Scorpio (the scorpion), Libra (the scales), Virgo (the virgin/maiden) and Leo (the lion), sequentially spread across the sky in positions relating to a span of astrological dates running 'backwards' from late November through to late July. The name Randall gave this meta-constellation, however, uses a different order to combine as "Virg(o, l)ibra(, )scorp(io & )leo". Possibly "Scorlibirgoleo", or a similar mash-up with the same source order, did not roll together nicely enough for his liking.

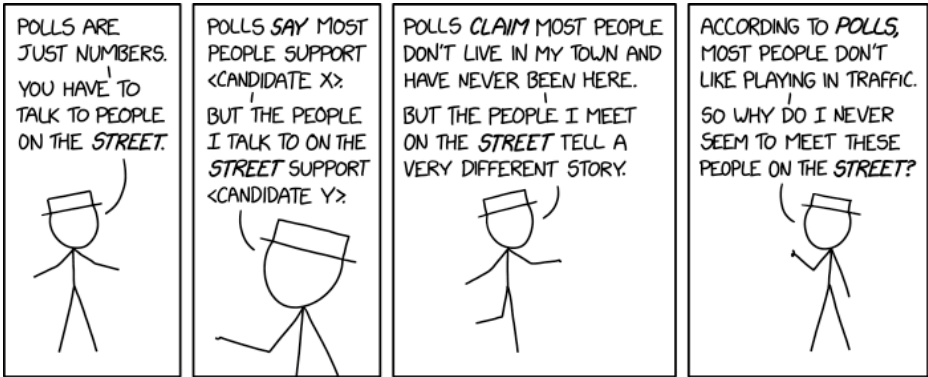
In reality, any apparent proximity of stars on the celestial sphere does not guarantee an actual proximity in the depths of space, either within or between constellations. Knock-on effects from this renaming would not change actual scientific understanding, but it could have a knock-on effect upon star catalogues and databases if this object regrouping forces so many incidental name changes to the current referencing system, which is why the astronomers are upset (as indicated in the title text). Similarly, astrology's conceit based upon four separate 'characters' and life-paths, arising from birth-signs and planetary transits across four distinct areas of the sky, would lose 'precision' if forced to accept a single symbolic area in their stead. Astrologers would be very upset because their work (interpreted charitably) is related to understanding the influences of the stars on life on Earth; they might be concerned that "crossing the stars" could lead to "disaster". It's not clear how Randall hoped to alter the practices of either group with his changes, but he was banned from the IAU for his efforts

(not the first time this has happened). Randall previously mentioned being banned from the IAU in 541: TED Talk, but the reason stated in that comic was "redefinition of the 'planet' to include the IAU presidents' mom", so presumably he was reinstated and then banned again.

This is another comic containing red annotations over a complex and established structure. This monstrosity is reminiscent of the infamous 2009 Dutch horror film known as *The Human Centipede*, in which three humans are bound together such that their digestive systems are connected in sequence. In this image, the head of Virgo appears to be connected to the hindquarters of Leo, and likewise the mouthparts of Scorpio are fixed to the bottom of the "stand" of Libra. Libra's stand appears to go under Virgo's dress; to form a complete "celestial centipede", it should attach to Virgo's hindquarters, but judging by the connection between stars, it probably (mercifully) connects to her foot.

## #2357: Polls vs the Street

September 09, 2020



Other pollsters complain about declining response rates, but our poll showed that **96%** of respondents would be 'somewhat likely' or 'very likely' to agree to answer a series of questions for a survey.

## Explanation

This comic discusses getting data or opinions through a study (polls) or by getting them anecdotally (on the street). The phrase "voice on the street" is commonly used by news reporters who get opinions on issues by literally asking people walking by what they think, and has been previously mentioned (and derided) in 756: Public Opinion.

Many news organizations, and other data-driven institutions, conduct or commission polls to assess the opinions of the general public. These polls generally rely on asking a randomly selected and anonymous set of people a set of consistent, prepared and deliberately crafted questions about their opinions, experiences, and intents. The results of these polls are traditionally held to reflect the views of the public as a whole, within certain margins for error. Many news shows also conduct "man-on-the-street" interviews (more formally known as vox populi, "voice of the people"), to provide a human face of "the public" and engage viewers more. Many pollsters, pundits, and politicians worry that polling data may not accurately reflect the true trends in public opinion, as in the infamous "Dewey Defeats Truman" newspaper headline, and so White Hat is here extolling the virtues of interviewing "real people" to get at that ground truth.

White Hat suggests that, while polls suggest "candidate X" is more favored, the people on the street that White

Hat interviews are more supportive of "candidate Y". He implies that his experiences reflect reality better than the polls. There are a number of reasons why polls may not be entirely representative. The sampling method might not be genuinely random, some groups might be less likely than others to respond to a poll, and it's argued that some people express views that they consider to be more socially acceptable, even in anonymous polls, but vote differently in actual elections (examples include the "Bradley effect" and the "shy Tory factor"). Despite these concerns, there is little evidence that individual conversations do a better job at determining public opinion than polling. However, attempting to get a person from off the street to report for a news anchor instead would obviously exacerbate all of these problems immensely, rather than fixing anything.

This comic is likely a reference to the 2020 United States presidential election, which occurred on November 3, 2020 (about 2 months from the time of the comic's publication), which Democrat Joe Biden won. Most polls showed Biden polling ahead of incumbent Donald Trump, but Trump and his supporters frequently argued that the polls are inaccurate, often arguing that they personally knew or talked to many Trump supporters, and few Biden supporters. At the same time, the fact that Trump won the 2016 election astonished many (including Randall) who had seldom met Trump supporters in their own lives and within their own social circles. This kind of anecdotal evidence is generally a poor basis for gauging public support, for multiple

reasons. Politics in the US are frequently regional, so sampling in a single area is unlikely to be representative of the whole country, or even a whole state. It's common for gathering places (both physical and virtual) to attract people from one political group more than another, producing a skewed sample. If someone uses their own perception, rather than rigorous analysis, confirmation bias is likely to have a major impact (a person might pay more attention to supporters of their preferred candidate, and ignore political opponents).

This strip lampoons such thinking, as it quickly becomes clear that White Hat's methodology is heavily driven by selection bias. He's apparently talking only to the residents of his town, and extrapolating those results to the whole country. By that logic, he would conclude that everyone has visited his town, and most people live there.

It is true that he's getting "ground truth", but it's also true that he's only sampling a very small (and highly idiosyncratic) part of the whole population.

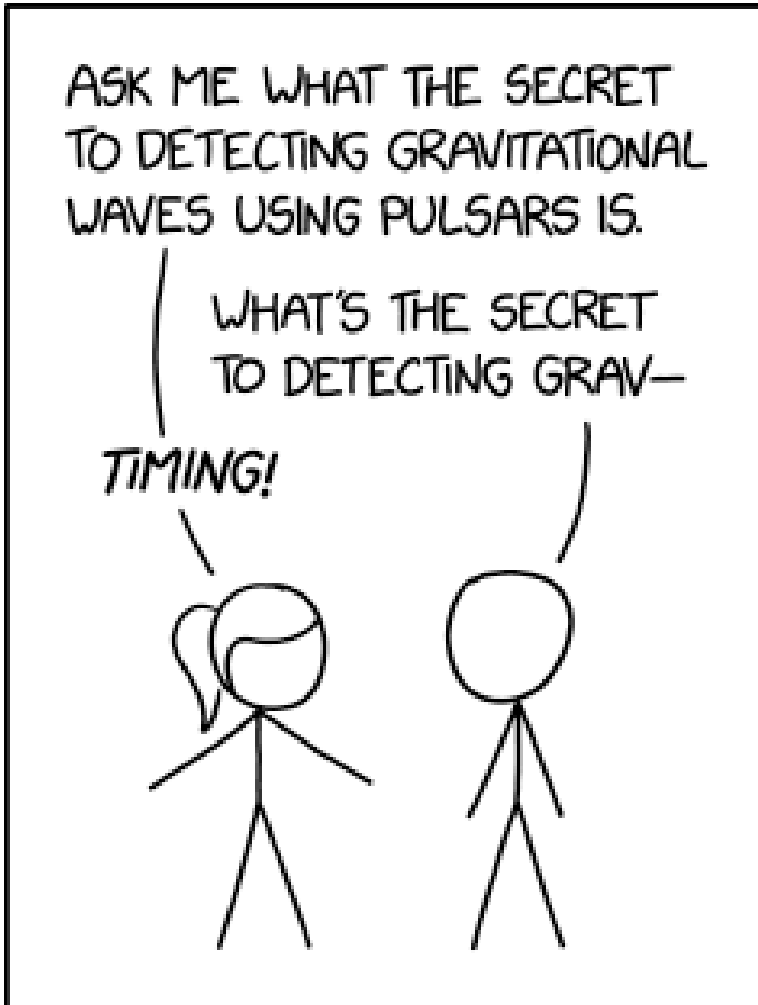
The punchline in the final panel is a joke about the phrase "on the street". Usually this phrase means "anywhere out in public where the interviewer can openly approach people" (often a sidewalk near the studio), but White Hat is presumably taking the phrase literally and interviewing people he meets on the roadway. In the US, roads are generally reserved for vehicles (cars, trucks, motorcycles and in most areas bicycles), and walking or standing in the roadway for long periods is dangerous and usually illegal. White Hat's sample population thus consists only of the people who

can be found on the roadway outside of designated pedestrian zones, who are generally from the small fraction of the population who have no qualms about the risks of being struck by moving vehicles or causing accidents when drivers swerve to avoid them.

The title text is a joke about selection bias (see Selection Bias) and tautology. People who don't feel like taking surveys wouldn't get as far as answering a survey question about survey questions. However, it does touch on an issue raised by FiveThirtyEight after the election: that polls only measure people who are interested in answering polls, and that population may not be politically representative of the entire country.

## #2358: Gravitational Wave Pulsars

*September 11, 2020*



The most important attributes of a vector in  $\mathbf{3}$ -space are  
Location, Location, Location



## Explanation

Pulsars are rotating neutron stars, which have a very precise period of rotation. Pulsars are highly magnetized, causing them to emit a beam of electromagnetic radiation that rotates across their sky. Radio astronomers can detect these beams if and when they point towards Earth, where they appear as pulses of radiation with highly stable periods. They use the pulsars' periodic beams to try to detect gravitational waves by tracking the rotation period of an ensemble of pulsars extremely precisely over long periods of time. Disturbances in the pulsars' rotation period will be measurable at Earth. A disturbance from a passing gravitational wave will have a particular signature across the ensemble of pulsars, and will be thus detected. The process is called "pulsar timing", or just "timing" for short.

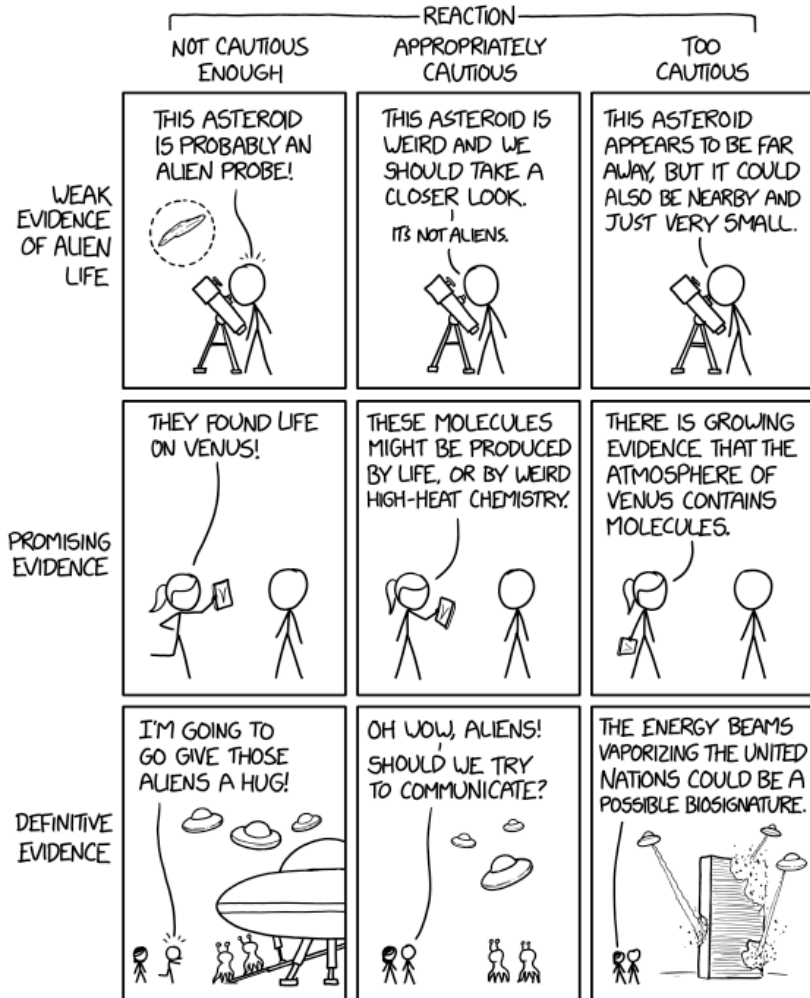
Ponytail presents this to Cueball as a joke - specifically, a joke about comedy. One of the most important aspects of comedy is revealing the punchline with correct timing. Ponytail sets Cueball up for a joke like, "Ask me what the secret of comedy is." / "What's the secret of--" / "Timing!" In this format, the punchline ("Timing!") deliberately comes too soon, which makes it funny because the timing is bad. Ponytail also replaces the secret to comedy with the secret to detecting gravitational waves with pulsars, to set up the joke about the word "timing".

The title text is a play on a well-known real estate saying that the three most important parts of a real estate deal

are "location, location, location." In 3D Euclidean space, the three Cartesian coordinates  $\{X, Y, Z\}$  all refer to locations along the three axes.

## #2359: Evidence of Alien Life

September 14, 2020



Both too cautious **AND** not cautious enough: "I'm skeptical that those are aliens, so I'm going to try pulling off their masks."

## Explanation

This comic depicts a table of possible responses to new information on the possibility of alien life. It is presented in table form, with the columns representing three categories of reaction to new evidence, and the rows representing the strength of new evidence, increasing down the table. Each intersection then shows a small scenario of what the response would be. The left and right-hand column scenarios are hyperbolic in either their acceptance or denial. The center column represents a reasonable course of action.[citation needed]

This comic was a reaction to the discovery of phosphine gas on Venus, which is where Ponytail's "V" figure in the second row comes from (a representation of the phosphine absorption feature). Phosphine is a molecule whose presence in the Venusian atmosphere came as a surprise. Light breaks phosphine down, meaning something must be producing it. However, there is no known abiotic mechanism on Venus that would produce the gas in the quantities observed. The phosphine could therefore be a sign of life on Venus, but more evidence is needed. Venus was also an unexpected place to find a possible sign of life — although it was a common pulp fiction setting in the early 20th-century, the arrival of the space probe era dashed hopes that the hidden surface might be, say, an exotic jungle (one of the more common pulp-fiction concepts). More recent efforts at finding life in the Solar System have mostly focused on Mars and various ice moons with suspected subsurface oceans, but

life more-or-less as we know it could exist within the upper atmosphere of Venus, which has more Earth-like conditions than the surface. However, while the discovery of phosphine is interesting, it is not nearly enough evidence to claim that "life has been found" on Venus, and likewise, it is comically understated to refer to the paper as "evidence of molecules" in Venus's atmosphere.

The title text refers to an action which is simultaneously too cautious and not cautious enough: the speaker is skeptical that aliens exist, which is usually an appropriate belief, except that presumably Megan and Cueball are in the situation presented in the bottom row, where aliens have landed right in front of them. Rather than modifying his belief (presumably it's Cueball, who was the one to approach the aliens in the other panels), he expresses an intention to approach the alleged aliens and attempt to remove their masks. He believes that he will expose a human wearing a costume, perpetrating a "Scooby-Doo"-style hoax, but no matter what the outcome is, he's acting rashly. If the beings before him are aliens, he will be initiating a very aggressive first contact and will likely receive a violent response, and even if the alien is not violent, Cueball might end up removing an environmental apparatus that is protecting it from Earth's environment (or vice versa). On the other hand, even if the "aliens" really are fakes, Cueball might end up injuring someone who is just playing a harmless joke (and who'd want to keep some kind of mask on to reduce the spread of COVID-19). Also, aggressively

reaching out to grab an impostor's mask and yanking on it might likewise produce a violent response.

## **Description of responses[edit]**

In the first row, an asteroid looks like an "alien probe". The "least cautious" response immediately jumps to the conclusion that the asteroid is an alien probe. The "too cautious" response simply ignores the possible implications of the asteroid and instead diverts either into a Socratic assertion or some other less relevant form of philosophical doubt, while the "appropriately cautious" response seeks to discover more pertinent information about the asteroid. Some humor is derived from the "appropriately cautious" response including a firm and unambiguous "it's not aliens".

The "alien probe" asteroid refers to 'Oumuamua, which passed through the Solar System in 2017. 'Oumuamua's hyperbolic trajectory indicated interstellar origin. Because of the unusual elongated shape suggested by its albedo (the object was never visualized as more than a point source of light) and indications of a slight non-gravity related acceleration, there were many wild speculations about 'Oumuamua's origin, including it being an alien probe similar to the one presented in the science fiction classic *Rendezvous with Rama*. The image of an astronomer looking through a telescope and being alarmed by seeing "something huge" which is actually very small and very close is an old comic gag, but the difference in parallax would immediately distinguish a close asteroid from a far one.

The second row refers to the discovery of phosphine gas on Venus, with the "least cautious" response to simply conclude that

there is life on Venus. The "appropriately cautious" and "too cautious" responses provide more general conclusions about "molecules" on Venus, with the latter adding nothing at all to our understanding.

In the final row, aliens have arrived on Earth. The insufficiently cautious approach is to immediately hug them. Cueball might make a new friend, but he might also be mistaken as an attacker, or perhaps the aliens are intending to make a meal of whoever approaches them. The more responsible approach is to (consider attempting to) communicate at a distance. In the final panel, the United Nations building is being vaporized by energy beams. This is technically "just" a "possible biosignature", as there are abiotic stellar events that produce energetic beams (although those are usually the size of planets or stars rather than buildings) and the beams could also be of human origin, but debating such semantics in the face of such destructive power seems excessively pedantic. For that matter, even though that panel is presented as "too cautious", it's only "too cautious" in the sense of "discussing the possibility of alien life"; Megan and Cueball are showing extreme lack of caution by remaining in the vicinity of an alien attack.

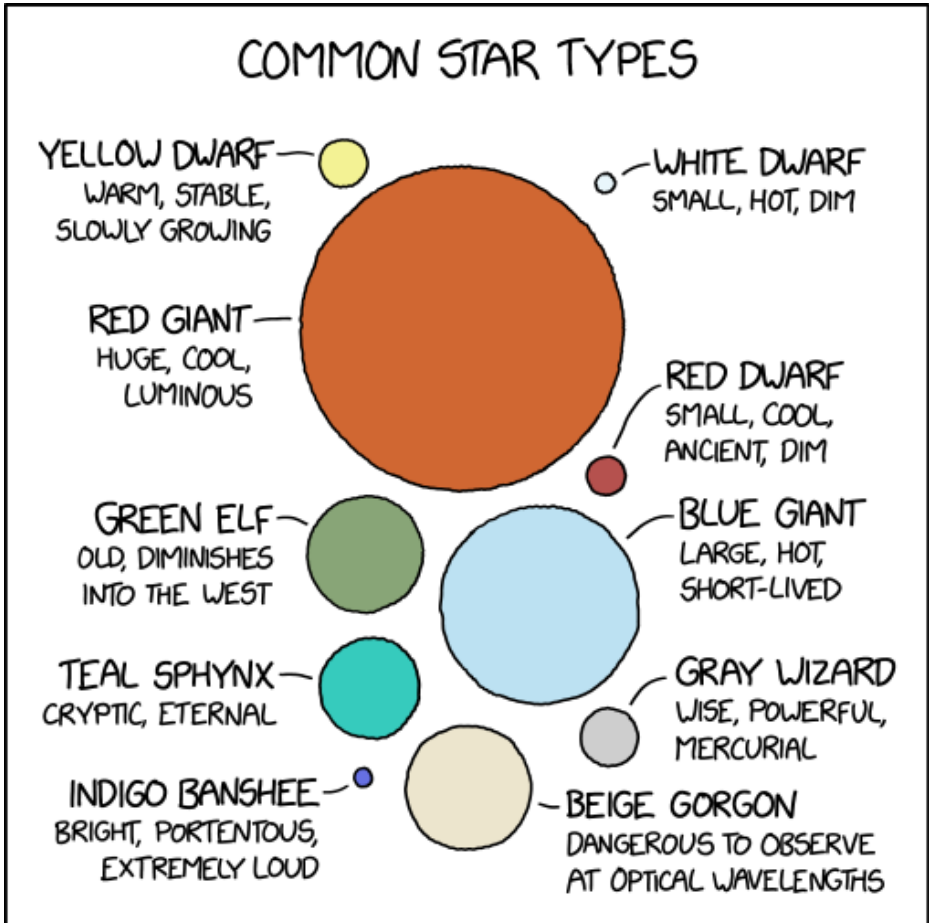
The destruction of human governmental buildings is a common trope in science fiction films, as a way of aliens removing the ability of humanity to co-ordinate a response to an attack. The United Nations building is allegedly the co-ordination centre for a worldwide response to an extraterrestrial incursion. However, since popular culture in the USA currently doesn't pay much attention to the United Nations, in American movies it is more commonly the White House or larger cities like New York or Los Angeles that get blown up by aliens. (While the United Nations

Secretariat Building is in New York, it would be a general destruction of the area and only notable cultural landmarks – perhaps the Empire State Building or Chrysler Building – or the general financial/commercial/social disruption are more likely to be dwelt upon in detail.)



## #2360: Common Star Types

September 16, 2020



This article is about Eta Carinae, a luminous blue hypergiant with anomalous Fe[II] emission spectra. For the 1998 Brad Bird film, see The Iron Giant (film).

## Explanation

This 'infographic' chart purports to be a comparative guide to various star types, often described by a basic color, which is something that even naked-eye astronomy has determined, and may be qualified as 'dwarf' or 'giant' to describe relative sizes. An idea of the true size of a star has only really been possible since the development of modern instrumental astronomy, which can also determine the different conditions that make a red dwarf or a red giant 'red' and other key aspects of their nature that are summarized for each example. See table below.

In true xkcd tradition, this is taken beyond reality. The pantheon of stars illustrated extend the use of 'dwarf' and 'giant' as if describing mythical or fictional beings, drawing upon others from the fantasy ilk with hues and shades that may not be typically described, or even encountered, by astronomers. The aspect information provided for these 'star' types is based upon the respective mythologies.

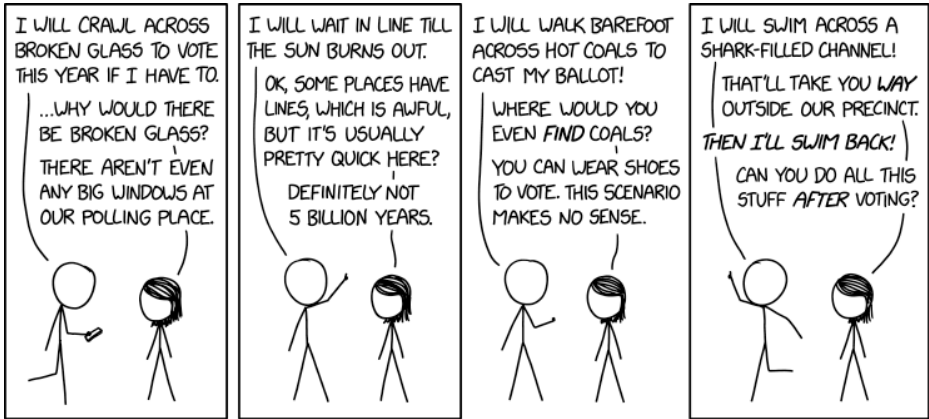
The title text is in the style of a Wikipedia page's hatnote / reference note. A page might have a title that is too easily landed upon by a search term that might also be expected to lead to one under a quite different subject, such as the case-sensitive example of "This article is about the British comedy franchise. For the type of star, see Red dwarf." In this case, it was written as if the page Iron Giant redirected to Eta Carinae, a large luminous blue variable star which has a relatively high level of ferrous

ions. Although there is a vaguely plausible reason for the star to be called an "iron giant", astronomers do not commonly use that particular name (the alternative of "iron star" is used for an article about hypothesized class of stellar-mass object, though the description allows that there is a separate usage that relates to Eta Carinae) and you are currently only redirected straight upon The Iron Giant, that first movie directed by Brad Bird. This note was added to Wikipedia, but quickly removed.

**Star types**[\[edit\]](#)

## #2361: Voting

September 18, 2020



'Wait, our state has mail voting. The forms are literally on the kitchen table.' 'Not now, I'm busy researching which channels have sharks in them.'

## Explanation

The run-up to the 2020 United States elections, occurring on November 3, 2020 (less than 2 months from the time of the comic's publication), has been fraught with various overlapping worries about the legitimacy of the forthcoming result. The COVID-19 pandemic has created a new interest in voting by mail, at a historically large scale. See Postal voting in the United States for more detail. Cueball, however, is in a very patriotic mood and makes a series of hyperbolic statements to Megan about the trials he would be willing to endure in order to vote in the upcoming elections, none of which would (hopefully), in reality, apply to his or anyone else's circumstance.

Crawling across broken glass might have actually been necessary at some polling sites of the 2001 New York City mayoral election primary, which had begun on September 11, 2001, and would have continued had it not been postponed two weeks due to the terrorist attacks of that day. However, as Megan states, their polling sites, unlike those of the 2001 election, don't even feature any especially large windows or other such structures from which broken glass could be derived. The idea of being so intent on doing something (in this case, voting) that a person claims to be willing to crawl across broken glass to do so is a common expression.

The Sun, currently a yellow dwarf star on the main sequence, will eventually expand into a red giant, then

collapse down to a white dwarf when its fuel is exhausted; this will not happen for billions of years, as Megan points out. Because of this, waiting until the sun burns out would result in Cueball's vote not being counted at all, both because it would be after the official deadline for ballots to be cast and because there would no longer be anyone alive on Earth.

As Megan observes, hot coals would most likely not even be present at their polling stations, and although some states have been accused of trying to make voting inconvenient or unsafe, this comic has not yet led any states to prohibit wearing shoes at polling places.

According to Megan, her and Cueball's municipality does not even include a single shark-infested body of water that Cueball would be able to swim through in order to cast his vote. Cueball's solution to this problem is to simply swim back to their location after swimming in his shark-filled channel.

Megan tries in vain to convince Cueball that his proposed actions are unnecessary or even impossible in their area, but, unable to bring him back to reality, she closes the final panel by asking if he'd be willing to put off all of this dangerous stuff until after voting, perhaps so that he will be alive long enough to vote in the first place.

Broken glass, the extinction of humanity, hot coals, and sharks aside, though, Cueball faces the risk of contracting COVID-19 from being in such close proximity to so

many other voters, as he seems to plan on voting in person (his words show his desire for activities only possible by way of physical action; in the title text, he also ignores Megan when she says that mail-in voting is available).

In the title text, Megan tells Cueball that he does not need to go to such lengths to vote, as their state has mail-in voting and already sent forms either to cast a ballot or to apply for mail-in ballots. Cueball ignores her and continues looking online for shark-filled channels to swim through. In doing so, he completely negates his professed desire to vote, as he is ignoring the easy path and going after paths that would end up making it impossible to cast his vote. Alternatively, he may just be caught in the normal rabbit hole of doing Internet research, where you start researching one thing (voting locations) and end up reading about another (locations of shark-infested channels).

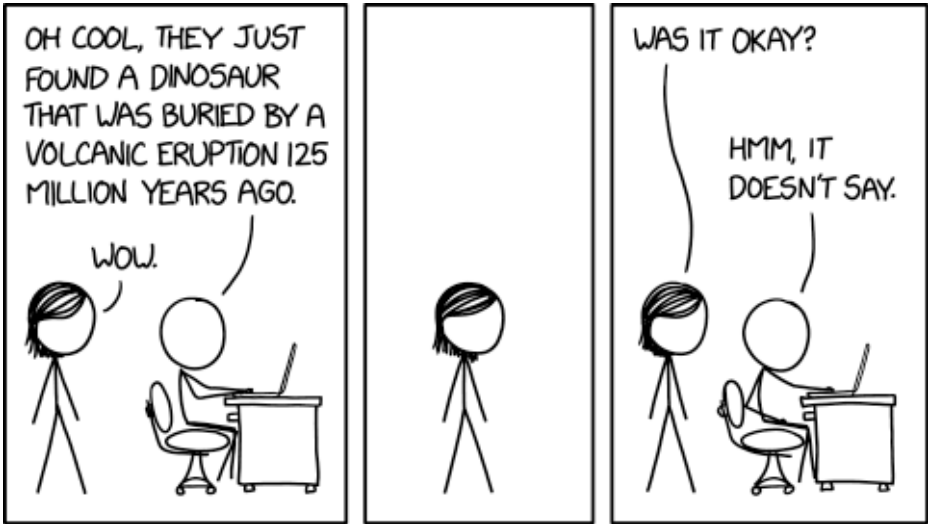
Randall is making the point that, despite apparent obstruction tactics and threats and attempts to de-legitimize the process, voting is very important (Cueball is using hyperbole to illustrate the importance), and relatively easy (as Megan keeps reminding him). He is also expressing an opinion that the increased danger of system compromise harming the legitimacy of the voting process due to massive mail-in voting is less worrisome than the corona-virus pandemic keeping people from voting at all, if in-person voting were the only viable option.

Randall lives in Massachusetts, a state with majority Democrat media, voters, and government. Sharks are sighted off Cape Cod on occasion, so if he really wanted to, he could swim with them, but unless he lives on Cape Cod itself, it would take him very far outside his voting district.



## #2362: Volcano Dinosaur

September 21, 2020



Phylogeneticists are working on identifying and notifying its next of kin.

## Explanation

This comic is a reference to this discovery of fossils of dinosaurs that were buried and killed by a volcanic eruption.

Megan asks if the dinosaur was okay. As living things typically don't survive being fossilized in volcano debris,[citation needed] the answer to the question would obviously be "no", but Cueball replies that he is unsure. Even if the dinosaur somehow survived the initial burial, it would be very difficult for it to survive being buried for 125 million years. 2020 probably wouldn't be the best year to dig it up and potentially let it free.

It is not an uncommon shortcut to refer to finds of relatively intact fossilized pieces of an animal using wording that sounds like they found an entire animal intact, as in the headline "New dinosaur discovered" rather than a wordier but more accurate "the fossil of a new dinosaur" or "the fossilized bones of a new dinosaur". Most parts of an animal dead for millions of years don't survive that length of time, and those that do are usually transformed into something else, such as bones becoming fossilized into rock and minerals.

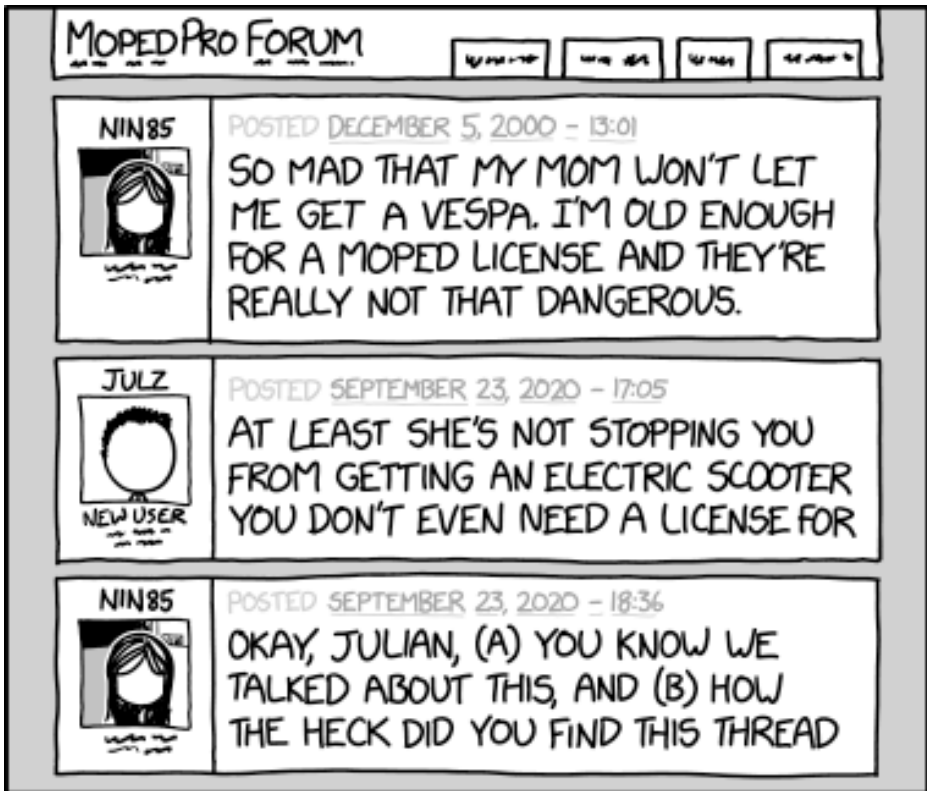
Megan's response is natural and expected in many situations when hearing of a person or creature experiencing misfortune. The humor here comes from the inaptness of asking the question millions of years

after the event. Rather than responding to the ridiculousness of Megan's question, Cueball takes it seriously, and deadpans that he can't tell.

The title text suggests contacting its "next of kin", which usually means a nearest living relative, e.g. a brother or a sister, and if not, the parents. The process of identifying and contacting next of kin is a standard step performed by authorities in the event of a death being discovered. The reason for this step is to allow the next of kin to exercise their rights to the property of the deceased under inheritance law. In this case, non-avian dinosaurs are extinct,[citation needed] so it is the job of phylogeneticists (those who study evolutionary relationships) to determine which living animal (presumably a bird of some kind) is the "nearest relative" to the deceased dinosaurs. However, even if the correct species could be identified, the specific animal would be all but impossible to find. Statistically speaking, that dinosaur is almost certainly either a direct ancestor of all living birds, or else an ancestor of no living birds.

## #2363: Message Boards

September 23, 2020



I LOVE THAT MESSAGE BOARDS ARE  
NOW OLD ENOUGH FOR THIS TO HAPPEN.

(c) You can have a scooter when you pay for it yourself, and (d) if you can't learn to start a new thread rather than responding to an old one, you'll be banned. [thread locked by moderator]

## Explanation

The joke of this comic lies in the dates of the forum posts and the (presumed) relation between the posters.

The initial post was made in 2000 by NIN85 who was, at the time, a teenaged girl (likely 14 or 15 years old given that her username ends in "85," implying she was born in 1985), complaining that her mother did not allow her to get a Vespa. Vespa is a brand of scooters and mopeds produced by the Italian manufacturer Piaggio. Most U.S. states require motorcycle licenses for any vehicle with an engine size over 50 cubic centimeters. Most Vespas are larger than this, although 49 CC models (classified as mopeds) do exist. Depending on the state, the minimum age to get a moped in the United States is 14, 15, or 16.

The reply was written in 2020 (twenty years later) by JULZ (or Julian), the presumed son of the now-adult NIN85, likely in his teenage years. The "Z" may refer to "Generation Z", paralleling the "85." "JULZ" complains about his mother refusing to allow him to get an electric scooter, which doesn't require a license. He is implicitly pointing out the hypocrisy of his mother, as a fifteen-year-old, thinking that teenagers with scooters are perfectly reasonable, while as a thirtyfive-year-old, being against the idea.

The primary source of humor in this strip (made explicit in the caption) derives from the fact that the Internet has been in common use for so long that teenagers can now

look up old posts that their parents made when they, themselves, were teenagers. The late 1990s to early 2000s was right around the time the average person would be expected to have access to the internet and use it regularly, which means that, as of 2020, that's been the case for around one human generation. This can be jarring for people who are still used to thinking of the Internet as a new technology. Noting how much time has passed since events that feel recent is a recurring theme in xkcd.

Of course, the basic premise of this exchange is nothing new. Teenagers have encountered (and been surprised by) the notion that their parents were once young for as long as there have been people. In the past, it's happened through finding old photographs, old videos, old diaries, or simply by hearing stories from their family and old friends. Young people are often shocked by what they learn, and accuse their parents of hypocrisy when they punish behavior that they once engaged in. Of course, this isn't true hypocrisy: we expect teenagers to grow and evolve, and develop mature, adult viewpoints. Parents naturally have both more understanding of dangers and lower tolerance for risk when dealing with their children. This strip points out that the internet has now existed for long enough (and preserves archives for long enough) that it's now become a potential medium for this whole dynamic. Part of the humor results from the unexpected situation that the child went to the trouble of tracking down his mother's old forum post, and that his mother is still active in the same niche forum 20 years later (as

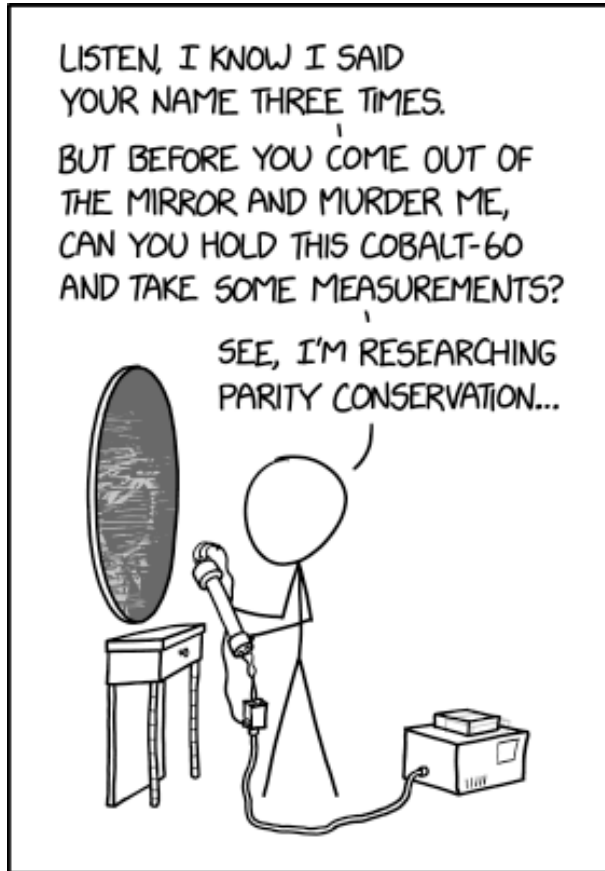
evidenced by her rapid response).

In the title text, the parent is apparently a moderator on that board now, or at least can quickly twist the ear of an actual mod. She has the thread locked (preventing further replies) and threatens banning the kid if he does not learn to post new threads, instead of dredging up dead threads from two decades ago. The act of reviving long-dead threads is often called "thread necromancy", "necroing" or "necroposting", and many forums (and users) frown upon it. It is seen as similar to bringing up a conversation from ages ago in real life. It often adds nothing new, and the original participants in the discussion may no longer be active or no longer interested in the topic. Some forums may actually encourage tagging onto existing but idle discussions (to add new or updated information), but this is not especially common, and does not seem to be the case here. This complaint also parallels the actual conflict here: bringing up someone's actions or attitudes from the distance past is generally frowned upon, just as posting onto old threads with a new argument is considered a breach of etiquette.

Invoking the power of moderation could suggest that, in typical parental fashion, she's using her greater influence and social position to end the discussion, making clear that she's the one in charge. "You'll be banned from this forum thread" could be seen as the Internet version of "as long as you live under my roof, you'll live by my rules".

## #2364: Parity Conservation

September 25, 2020



IT TOOK SOME NEGOTIATING, BUT I'VE  
FINALLY BECOME THE FIRST PERSON TO  
COAUTHOR A PAPER WITH BLOODY MARY.

Bloody Mary is made of antimatter. It explains so much.



## Explanation

Bloody Mary is a legend of a ghost, phantom, or spirit conjured to reveal the future. She is said to appear in a mirror when her name is chanted repeatedly. This is why Cueball says he said her name three times. This is her second appearance in xkcd, the first being 555: Two Mirrors.

The remark on parity conservation and cobalt-60 is likely a reference to the Wu experiment. In 1956, physicist Chien-Shiung Wu and her team at the National Bureau of Standards used cobalt-60 to show that the weak interaction breaks parity: beta particles leave the decaying nucleus in the direction opposite to nuclear spin.

One of the results of this is that it becomes possible to differentiate between the concepts of left and right on a purely technical level, even if the person (or distant alien) you're talking to can't see you. When we say that "parity is not conserved," we mean that the concepts of left and right are not purely symmetrical across all areas of physics. As Richard Feynman put it, this means that "nature's laws are different for the right hand and the left hand, that there's a way to define the right hand by physical phenomena."

It seems as if Cueball is trying to "hand" Bloody Mary his experimental apparatus either physically (as he is asking her to take the cobalt-60 "before [she] come[s] out of the mirror"), or perhaps by reflecting it onto her side.

Because Bloody Mary exists in mirrors, her world is implicitly a mirror of ours. This would allow her to conduct mirror physics experiments, such as whether or not the beta particles leave the cobalt-60 in the same direction as they do in our universe.

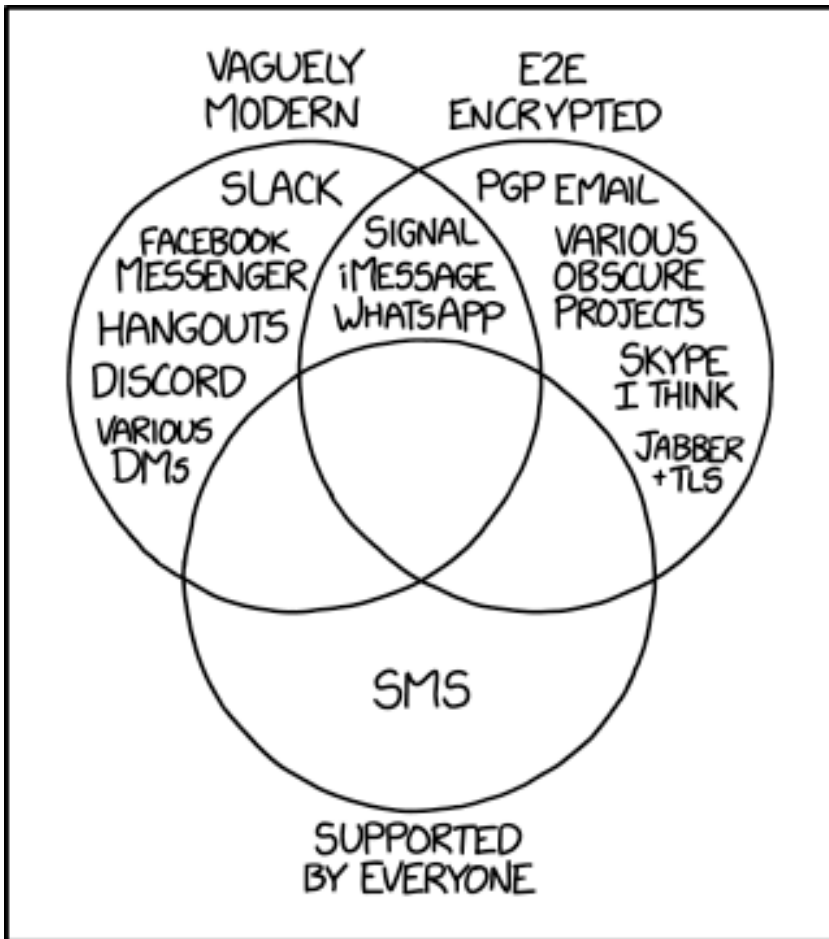
The title text references antimatter. In physics, antimatter is like a mirrored version of matter — mirrored in charge, parity, and time — composed of antiparticles rather than particles. Antimatter and matter spontaneously annihilate each other when they meet, releasing extremely high-energy radiation. Therefore, Bloody Mary being made of antimatter explains why she kills people when she comes out of the mirror. (Bloody Mary would also be annihilated in such an interaction, so the fact that she keeps coming back may be attributable to her being a ghost.)

There have been a lot of science fiction-y stories featuring antimatter people; often, these are duplicates of "regular"-matter people. The stories often show unrealistic ideas of what would happen if matter and antimatter versions of people met. Sometimes, the duplicates simply disappear; sometimes, if the plot requires it only one may disappear. Or sometimes the entire universe is destroyed. In reality, what would happen is that the matter and antimatter would mutually annihilate, as pairs of subatomic particles, creating enormous radiation and heat. It's likely that only a small fraction of the matter and antimatter would actually come into contact, rather than being propelled apart by the explosion. Indeed, if the duplicates are in their

versions of air, the air and anti-air particles would interact first! Even in interstellar space, an antimatter alien would give off significant radiation from collisions with matter particles. In these stories, it's often presumed that the corresponding duplicates of people can annihilate only each other, but can safely touch anything else. In reality, the matching is at the subatomic level: any proton with any antiproton, any electron with any antielectron (or "positron"), etc.

## #2365: Messaging Systems

September 28, 2020



### WHY SMS REFUSES TO DIE

SMS is just the worst, but I'm having trouble convincing people to adopt my preferred system, TLS IRC with a local server and a patched DOSBox gateway running in my mobile browser.

## Explanation

Messaging systems suffer from the network effect, as in order to communicate, both parties need to be using the same system. Though relatively ancient by modern standards, SMS is supported by almost every mobile device (unless you're using a kosher phone or still on a DynaTAC) that has a phone number attached, which means if you want to send a message to someone, but aren't sure if you have a messaging protocol in common, you can be sure at least they have SMS. The comic mentions many other communication systems, which offer various advantages in either security (end to end encryption) and or a bunch of general improvements filed under the label "vaguely modern", such as longer character limits and the ability to share media such as images in-service.

The messaging systems are shown in a Venn Diagram, with the categories corresponding to these three advantages. The intersections between the categories are very minimal: there are a few systems that have both E2E encryption and are modern, but no intersections with "supported by everyone", and SMS is the only system in that category. So when choosing a method of communication, you're usually faced with a compromise. Various other comics have referenced the issue of chat services, including 1810: Chat Systems, 1254: Preferred Chat System, and 1782: Team Chat.

The title text proposes an alternative, absurd mingling of

technologies in the vein of 1636: XKCD Stack. IRC is Internet Relay Chat, a similarly antiquated messaging service that may also never die, as suggested in 1782: Team Chat. Transport Layer Security (TLS) is a layer of networking software that provides encrypted communication. DOSBox is an emulator that recreates the operating environment of MS-DOS; part of the absurdity is that DOSBox is intended almost solely for video games. Additionally, this hodgepodge of technologies is running in a mobile browser, instead of a dedicated server or machine.

### **Vaguely Modern[edit]**

#### **E2E Encrypted[edit]**

End-to-end encryption refers to messaging systems where only the communicating users can read the messages posted. In principle, it prevents potential eavesdroppers – including telecom providers, internet providers, and even the provider of the communication service – from being able to access the cryptographic keys needed to decrypt the conversation.

### **Vaguely Modern & E2E Encrypted[edit]**

#### **Supported By Everyone[edit]**

September 30, 2020

I told her I'd take her address off the packaging if she'd stop submitting anonymous food safety complaints about my bakery to the health department, but she sent me a note that said **NO DEAL** along with an extra large batch of

cookies.



## Explanation

The comic portrays the back side of a box of cookies (evidenced by the nutrition facts-style table on the left side). Many brands have a romanticized origin story on their packaging explaining the name or how they have a secret ingredient. Instead, this brand's origin story is a tale of petty one-upwomanship as the brand's founder sets out to prove that her cookies are better than her grandmother's.

The first paragraph lovingly describes the founder's memories of sitting in her grandmother's kitchen, watching her bake cookies. One would expect this to transition to a description of how delicious those cookies were, and a claim that her recipe became the basis for the cookies being offered for sale, as a family recipe or something similar. Instead, 'Amelia' insists that her grandmother's cookies were awful, and insists that the goal of her company is to show how cookies are supposed to taste. This subversion of expectations breaks down the sense of nostalgia that's often used to market products, and publicly embarrasses her grandmother, turning a minor family squabble into a very public fight. Such is a very unusual strategy for convincing people to buy cookies, and would probably not work very well.

To complete her revenge, the "story" contains the grandmother's address. Creating false addresses for their mascots is often used as a publicity stunt for children to write testimonials to the brand's PR or marketing

department. However, here it appears to be Amelia's actual Grandma's actual address, the goal being for her to receive thousands of letters on a regular basis about how her granddaughter's cookies are so great, while jabbing "unlike yours!", which could qualify as cyberbullying.

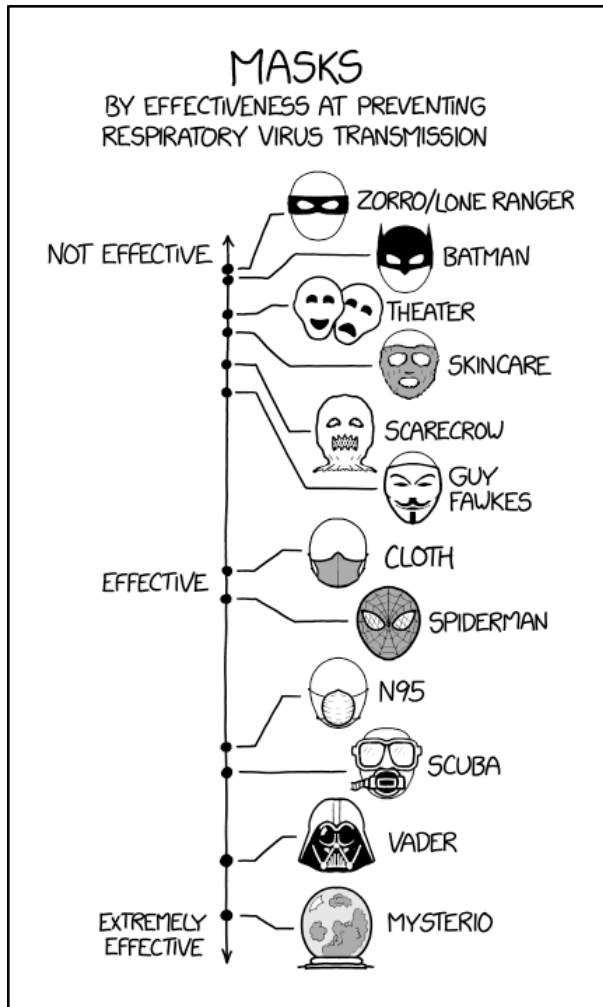
In retaliation, Amelia's grandmother has started submitting (presumably bogus) food safety complaints about Amelia's bakery to the health department in a ploy to overburden the bakery with unnecessarily frequent inspections. At one point Amelia eventually decided to offer a truce, which her grandmother emphatically rejected, underscoring it by sending Amelia an extra-large batch of the cookies she knows Amelia hates. Alternatively, she may be sending these cookies because she will submit a complaint after Amelia has received the cookies, as these cookies are definitely health code violations, as normal cookies do not have gooey exteriors.

While the name of the city past the first letter and at least one of the zip code digits is too illegible to read, by process of elimination it is plausible that the city is Orlando and the zip code is 32841. However, 32841 is not a valid US zip code. No other location in Florida consists of one word starting with O and a zip code legibly close to the one in the comic. The problem is that the street clearly ends with "Ln" and the street name has neither ascenders nor descenders other than the initial capital "A". This might recommend "Anson Ln." but the street number starts with a 1 while the actual Anson Ln. has numbers all in the 4,000s. Similar problems arise for all of the streets with one or two ascenders/descenders or

even with possible omitted letters or even entire words.

## #2367: Masks

October 02, 2020



Haunted Halloween masks from a mysterious costume shop that turn you evil and grow into your skin score a surprisingly high **80%** filtration efficiency in R. L. Stine-sponsored NIOSH tests.

## Explanation

This comic is another in a series of comics related to the COVID-19 pandemic.

This comic is a line from top to bottom explaining how good different types of masks are at preventing respiratory virus transmission. This comic may have been inspired from a Polygon article published on May 15th.

### Types of masks[edit]

- Zorro/Lone Ranger: A strip of cloth around the eye-level. Since it does not cover the mouth and nose, the main ways the virus leaves the body to infect others, or the mouth, nose and eyes, the main ways it enters the body, it is ineffective and no better than wearing no mask at all.
- Batman: Batman's iconic headgear has gone through many revisions, and consists either of a simple cloth cowl or a helmet and visor. Does not cover the mouth, but may cover the nose. However, the mask only covers the top part of the face, i.e., not the mouth or nostrils. This mask might be slightly more effective than the Lone Ranger style mask due to the intimidation effect keeping other people back, and depending on its length, it might help direct air that the wearer breathes out down instead of towards others' faces, which would reduce the risk of spreading any respiratory diseases that the wearer may be infected with.
- Theater masks (Sock and buskin): Traditionally used as a symbol of performance theater since ancient Greece. The eye and mouth holes are often open, thus exposing the wearer.

- Skincare (facial mask): A layer of mud or moisturizer. By nature, it does not cover the mouth or nostrils, but it may keep the wearer from touching their face and is usually worn by someone sitting in a chair or lying back on a bed, not out getting in other people's personal space.
- Scarecrow: A burlap sack. While it provides some cover to the mouth and nose, it is heavily porous. This could also refer to the Scarecrow, a DC Comics villain. If so, the mask would probably be much more effective than an ordinary burlap sack, as that character uses airborne drugs as weapons, and would have to have very good filter ability to protect himself.
- Guy Fawkes mask: A plastic mask that is a stylized depiction of Guy Fawkes (designed by David Lloyd for the comic book V for Vendetta and made popular by its movie adaptation and subsequent adoption by the Anonymous movement). Most Guy Fawkes masks provide small holes in the front for comfort, thus facilitating spread of the virus.
- Cloth: A cloth mask that blocks most large particles, like virus-laden saliva. To be most effective, it must cover nose as well as the mouth. These are much cheaper than N95 masks, and can be reused by washing. Not all cloth masks are created equal, some designs and materials are more effective than others at holding back contagious particles, but Randall lists them under "Effective" on the whole. They are relatively effective at preventing the wearer from infecting others, but are less effective at protecting the wearer from being infected by others, because droplets leaving the body are large enough to block, but small enough to get through cloth after evaporation. The felt-like nonwoven fabric of surgical masks blocks more droplets and aerosols than the same thickness of knit or woven fabric.

- Spiderman[sic]: A full face covering of spandex-like material (Spider-Man comics rarely if ever specify what material Spider-Man makes his costume from). Would block most virus particles. (The correct spelling is "Spider-Man", with a hyphen, and "Man" capitalized.)
- N95: A standard air filtration mask, commonly used in industry but also used in healthcare. The name "N95" signals that it is not resistant to oil, but successfully filters 95% of airborne particles. It has proven to be one of the more successful masks during the 2020 pandemic. N95 masks usually include non-woven filtration material, which is more similar to the felt-like fabric of surgical masks than to woven cloth. N95 masks can filter particles much smaller than the gaps between layers and strands in the fabric.
- SCUBA: A Self-Contained Underwater Breathing Apparatus. Most SCUBA equipment used an open-circuit design allowing exhaled air to vent to the atmosphere. Underwater, this would not be a threat to other divers who would also be breathing air from their tanks. However, on land a typical SCUBA regulator would expose others to virus particles. Closed-circuit SCUBA equipment recirculates the user's gas supply but they still contain a means of venting extra gas into the atmosphere. Neither system contains expiratory HEPA filters making both ineffective at preventing virus transmission. That all said, SCUBA equipment still covers the face and nose, rather than directly exposing others to unshielded breathing and coughing.
- Vader: Reference to one of the main antagonists in Star Wars, in which he wears a suit of armor with a built-in rebreather. Similar to SCUBA gear, it circulates air back to the user, in order to defend against the spread of the virus to the wearer. The

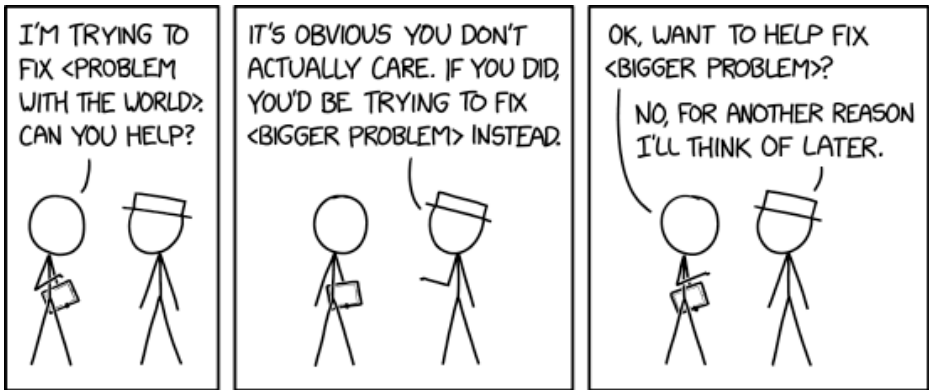
question of whether Vader's mask would protect against COVID was implicitly referenced again in 2441: IMDb Vaccines.

- **Mysterio:** Reference to one of the antagonists in Marvel Comics' Spider-Man as part of the Sinister Six. He wears a glass helmet. In the comics Mysterio often uses mind-altering chemicals, and his suit is designed to shield himself from his own weapons. By the same design, it would shield himself and others from the spread of viral infection. He might also not even be in your presence if, especially as in the film version, the Mysterio you see is himself currently an illusion.
- **Haunted Halloween Masks:** The title text is a reference to *The Haunted Mask* by R. L. Stine, a book in the Goosebumps series. The mask transforms the wearer into a monster, with an open (uncovered) nose and mouth. The test results claim that the wearer is still somehow substantially protected against inhaling virus particles, but this may be a fraudulent test result due to pressure from the sponsor of the test, R. L. Stine, to get more people to wear such masks; it is also possible that the supernatural effects somehow include blocking virus particles, as parasites generally benefit from keeping their hosts alive and healthy, at least in the short term; it is further possible that, due to wearers having a stronger immunity in monster-form, they simply defeat the virus even before suffering its symptoms. NIOSH refers to the National Institute for Occupational Safety and Health.



## #2368: Bigger Problem

October 05, 2020



Your point that the world contains multiple problems is a real slam-dunk argument against fixing any of them.

## Explanation

Cueball is asking White Hat to help fix an unspecified problem with the world. Presumably, he is working for some form of charity and perhaps asking for donations or signatures. White Hat responds by saying that Cueball doesn't care (about, presumably, the world) and that he would be working to fix an unspecified larger issue if he really cared. Cueball then asks if White Hat would rather be working to solve that problem. However, White Hat says that he doesn't want to, but that he also hasn't come up with an excuse not to yet. White Hat seems as if he couldn't be bothered, and wants to go on with his life.

The claim that someone is not working towards an important issue, while not always completely invalid, is commonly used as a cheap tactic to ignore a solution to a problem, even when the person using it does want to help out with either cause and is also a logical fallacy known as the "Not as bad as" fallacy, Fallacy of Relative Privation, or Appeal to Worse Problems. In the last panel of this comic, White Hat reveals that he isn't sufficiently devoted to either cause to act on them, so that his bringing up the larger issue appears less like interest in the larger issue than an excuse to not support Cueball's cause.

The title text furthers this point. While the argument used by White Hat is supposed to imply that the person giving the argument cares about an issue that matters more (to the exclusion of the other issue), it's often used,

as seen in this comic, as an excuse to not work to fix any problem, making it "a real slam-dunk argument against fixing any of them."

Both causes in the comic are referred to ambiguously and surrounded with angle brackets to imply that they can be filled it with any two problems, as the comic is supposed to depict a common situation that happens during discussions of many different causes.

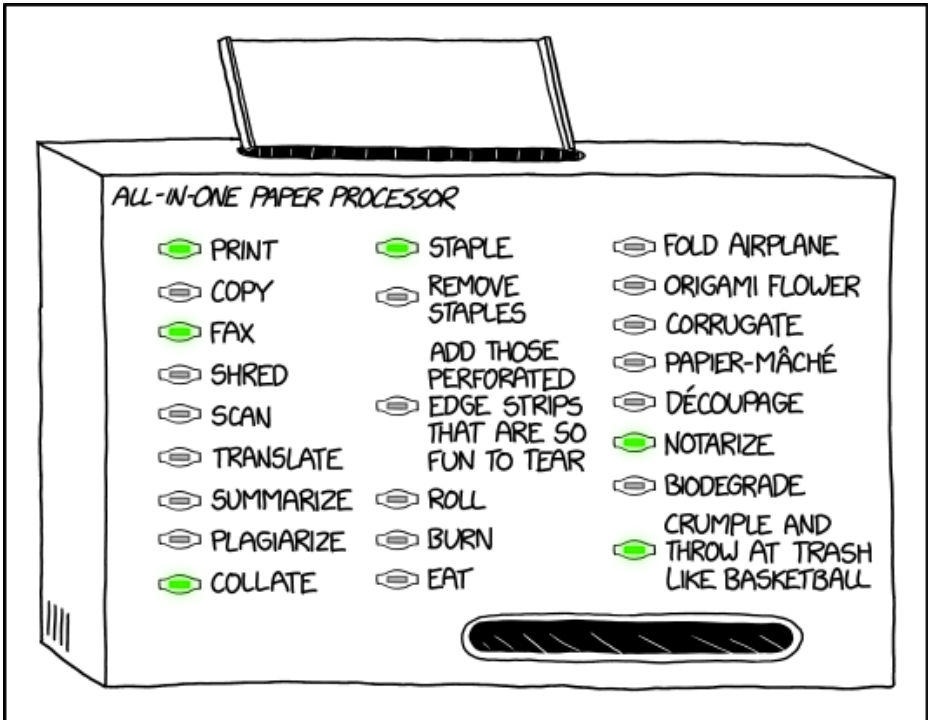
This comic is quite similar to 871: Charity because both have a character that responds to people trying to help "by figuring out a reason that they're not really as good as they seem". Additionally, it seems to relate to 1447: Meta-Analysis on being very meta. 1232: Realistic Criteria has an extremely similar conversation between Cueball and White Hat.

People sometimes use similar fallacious reasoning against themselves, thinking that they shouldn't tackle "simple" "unimportant" problems when there are "important" problems outstanding, even if the former are within their ability to handle but the latter aren't. This can be a form of self-sabotaging behavior.

In essence, this may be an example of the principle "The perfect is the enemy of the good." That is, it is better to make a small advance which does some good. If you insist on doing nothing until you cure everything to perfection, nothing will be done.

## #2369: All-in-One

October 07, 2020



Changes with this update: If you use the combined scan-shred function, it now performs them in that order instead of the reverse, saving a **HUGE** amount of CPU time.

## Explanation

This is a parody of an all-in-one printer, a printer which typically can perform several functions, usually printing, scanning, copying, and faxing. This machine starts off with fairly standard printer functions but quickly becomes absurd. The machine is accordingly oversized, making room for all the status indicators and (presumably) the extra internal parts required to accomplish the uncommon functions.

The title text reads like a software update's patch notes; the mentioned feature says that if both the "scan" and "shred" options are selected, it now scans documents before trying to destroy them. This indicates that, prior to this update, the machine destroyed documents and then scanned the pieces and tried to reconstruct them, identifying the original location of each shredded piece on the original sheet(s) of paper, which takes a large amount of processing power. Such a matter SEEMS like an unrealistic oversight on the developers' part, but real developers of both games and machinery have made similarly huge errors both before and after this comic was uploaded.

### List of functions[edit]

Certain functions are lit green, indicating they are in use. To show which ones are in use, they are highlighted green (selected).

- Print (selected): The most common function that a printer needs to do. A digital document or graphic exists on a

computer, is sent to the printer and the printer transfers the document onto paper using ink or toner.

- Copy: A copy function allows a user to place a document on the integrated/linked scanning bed and the printer will immediately make a copy of the document as if it were a traditional 'analogue' photocopier.
- Fax (selected): A fax function sends a scanned document by telephone to another telephone number. The receiver fax machine will reconstruct the document and print it. A machine that has this function is usually also able to act as a receiver for faxes sent from elsewhere, though that setting wouldn't be visible in this configuration group.
- Scan: A scan function is used to optically scan images or documents into digital forms so that they can be used by computers. It can be seen as the reverse operation of the printer function.
- Collate (selected): To sort multiple copies of printed documents into sequences of individual page order, usually across multiple output trays having one sequence for each copy, especially before binding.
- Staple (selected): To staple together multipage documents, especially for each collated copy. This function is usually found only in high-end printers.
- Staple Removal: Although mechanical removal of staples can be done by various devices, it's often not a simple task. Staples can be bent and mangled in many ways, and detaching them from paper without causing damage can require fairly complex intelligence.
- Shred: A shredder function is used to destroy paper for privacy

or security by cutting it into strips or fine particles. Normally this task is handled by another specialised machine called a shredder, but this time it is already inbuilt into the printer.

- **Translate:** If the paper text is in another language, this would presumably translate it for you — after scanning and OCRing. This would actually be a helpful function and may be available on recent scanner-printers, although usually in the software that comes with the printer, on the host computer, rather than inside the printer itself.
- **Add those perforated edge strips** that are so fun to tear: In an earlier era, dot matrix printers and line printers were the common standard, and used a type of continuous stationery, which was manufactured with perforated strips along each side, with regularly spaced holes which allowed spiked wheels to advance the paper through the printer. Tearing these strips off after printing was once a standard task when using a printer. This type of stationery is now obsolete, but many people of Randall's generation become oddly nostalgic about removing the strips from the old style of paper -- the strips are kind of fun to play with. Note that the old stationery was designed such that the remaining page typically had a "standard" paper width, with the strips adding additional width. It's unclear if this function is adding perforations to standard paper, which would leave it too narrow once the resulting edge strips were removed, or is somehow adding perforated strips to it.
- **Summarize:** Presumably this function would summarize a printed material for the user. Similar to the translate function, a document would need to be scanned and OCRed first. Then a machine learning algorithm would comprehend the text and reduce it in length while keeping the important points.

Automatic text summarization does exist, although the technology is not as widely used as automatic translation.

- Plagiarize: This function is unclear. Maybe it would plagiarize a paper for a certain subject? It would also be legally questionable. (Maybe it plagiarizes printer techniques, in which case this might be useful, though only in edgcases)
- Roll: This function would probably roll up paper into a roll, like how the newspaper is rolled up for distribution by paperboys.
- Burn: Perhaps the printer has this function for greater assurance that sensitive information will be irretrievably destroyed. Historically, some printers could be at risk of catching fire if they jammed in a particular way, and so the "lp0 on fire" error code was created to signal that it should be investigated urgently.
- Eat: A printer is often said to "eat" paper by mangling either the input or output. Printer failure is also the modern descendant of the classic excuse for late homework, "the dog ate my homework".
- Fold airplane: This function makes paper airplanes out of paper stored in the printer, or documents being printed. Paper airplane folding machines are a thing, so it'd be possible to design something to fold an origami flower, as well.
- Origami flower: Similar to the previous one, this function makes flowers using the origami paper folding process.
- Corrugate: Corrugated fiberboard or cardboard is a kind of crinkled paper sandwiched between two sheets. This provides structural strength for low weight. Printers that jam can produce a paper that looks corrugated, but this is not an intended function, and corrugated fiberboard is not made with



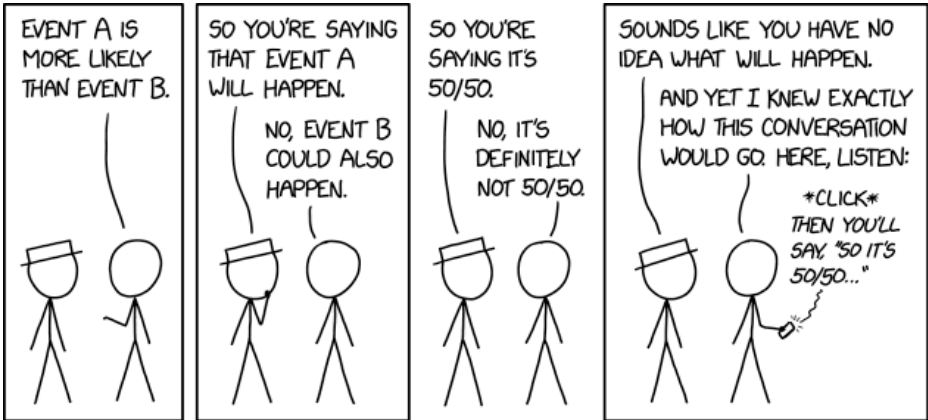
printers.

- Papier-mâché: (Literally "chewed paper") is a composite construction material consisting of paper pieces, bound with an adhesive, often a flour paste. The printer could use its "shred" and "eat" functions to produce the necessary materials, and any leftovers could be composted with the "biodegrade" function.
- Découpage: An art form where paper printed with decorative images is glued onto an object (typically boxes, but also furniture) and covered with many layers of varnish so that the images appear painted onto the object.
- Notarize (selected): A notary public is a person certified by a government to attest that certain kinds of legal documentation are legitimate and executed. All-in-one printers and scanners may be able to recognize certain signs of legitimacy (e.g. the EURion constellation), but unless this printer has some tactile sensation, it cannot certify the identity of the person who signed the document as a human can.
- Biodegrade: This would biodegrade the paper. Whether this would send it to an organic waste plant (which would be helpful) or actually house a composter inside the printer (which would be gross[citation needed]) is unknown.
- Crumple and throw at trash like basketball (selected): Many people, when done with a piece of paper, will crumple it up and throw it into a trash can from a distance as if playing basketball. This wouldn't be a very useful feature in a printer, especially relative to its complexity.[citation needed] For one thing, it would prevent the person who printed the document from using it (even if the user intends to throw away the paper eventually, presumably they need to use it at least once or they

wouldn't print it), and it would also deny the user one of the few pleasures available in the office environment. The specificity of this function name could suggest that other models of this printer (Even-More-In-One?) could imitate other sports, such as paper football.

## #2370: Prediction

October 09, 2020



You'd think it'd be easy to just bet money against these people, but you have to consider the probability of them paying up.

## Explanation

This comic is about misunderstanding probability. Saying that one event is more likely to happen than another is not the same as saying that the first event is definitely going to happen. A statement like "event A has a 70% probability of happening" sometimes misleads people into believing that event A is inevitable, while in fact 3 times out of 10 event A will not happen.

For example, FiveThirtyEight famously gave Trump a higher odds, 28.6% of winning the 2016 U.S. presidential election than most other models did just before the election, but still not more likely than his opponent. However, many readers at the time interpreted that as "Trump is definitely going to lose", and after he won that election, blasted FiveThirtyEight for getting its prediction "wrong". However, that interpretation is mistaken. 28.6% means Trump had a real chance at winning: if you could put election results in a hat and draw them at random, he would win two out of every seven tries. For another example, in tabletop gaming terms, Trump's likelihood of winning was slightly lower than that of passing a flat check with a DC of 15 (6/20 or 30%).

So, the correct interpretation of a probability statement like "event A has a 70% probability to happen" is that in the long run, about 70% of events with this probability end up happening.

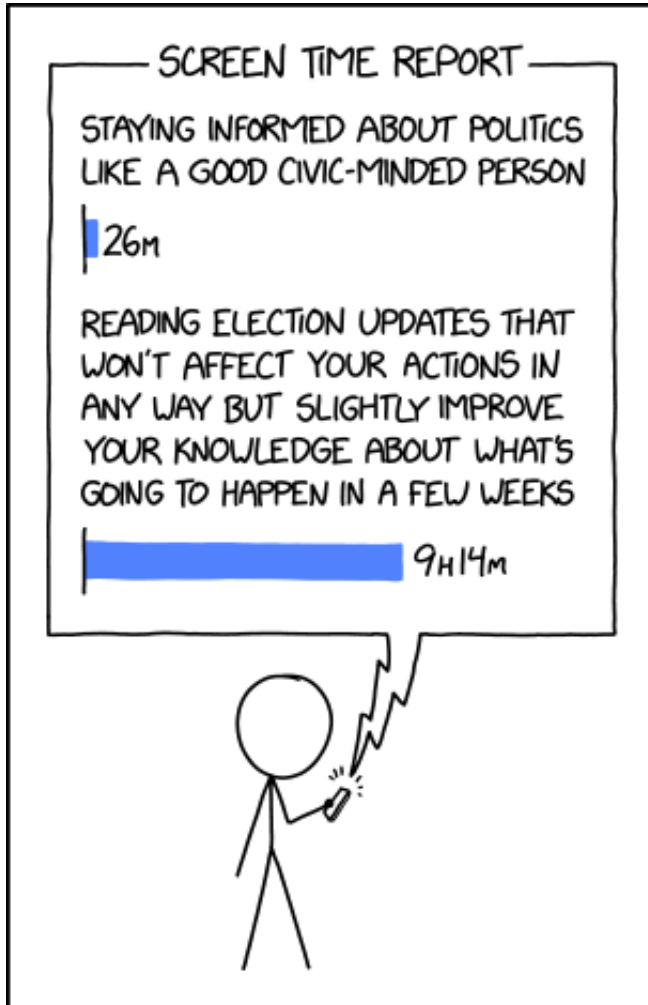
In the last panel, it is shown that Cueball anticipated this lack of understanding, so he plays pre-recorded audio of his prediction for the conversation.

The title text says that these people are gullible enough to the point that they would accept a disadvantageous bet. However, it also says that the probability that they might not actually go through with paying the bet if they lose brings into question whether to propose the bet is actually worth it. Randall has previously made allusions to betting on fallaciously claimed probabilities in comics such as 1132: Frequentists vs. Bayesians and 955: Neutrinos.

At the time of writing, the 2020 United States presidential and congressional elections are less than a month away. This is a time when polls showing one or the other candidate leading are common, and may be misinterpreted to mean that the candidate is certain to win. Additionally, after the 2016 election saw Donald Trump, the trailing candidate in the polls, winning, many also interpreted this to mean that the polls were useless and/or wrong, or even go beyond this and take an adverse poll prediction as a perversely authoritative indication that the exact opposite result (which they would favour) is now a certainty. Cueball has previously shown an interest in U.S. election polling, for example in 500: Election.

## #2371: Election Screen Time

October 12, 2020



Feels like I picked a bad year to try to start having a healthy relationship with political news.

## Explanation

Cueball has an app on his phone which informs him of the time spent using it for various purposes. These are typically used to monitor one's own, or maybe one's teenage child's, (over)use of games, social media apps, general browsers, etc., and highlight any surprising issues.

It is unclear whether this is: a specific analyser, that somehow identifies just this narrow subset of uses; a more general app, currently filtered to give information on just these two politics-related interactions via some complex heuristic method; or he actually does nothing but these two classifiable things, on this particular device.

Whichever is the case, it is currently displaying and comparing just two curiously detailed statistics - the time used staying informed about politics, and the time he has spent reading election updates - and nothing else. The total time recorded would be a large slice of someone's typical day, if the report is for the last 24 hours, but is overwhelmingly dominated by the latter activity whatever the duration covered.

The comic reflects that most people spend a lot of time consuming news speculating about who will win the upcoming election, even though reading these "updates" will have no impact on the election because people are unlikely to change their minds because of them. People spend very little time researching information that will allow them to make informed decisions about voting, which is an important civic duty. In addition, a recent

article in The Atlantic said that "Reading Too Much Political News Is Bad for Your Well-Being".

The title text suggests regret about the time spent consuming political news, possibly reflecting the sentiment that the 2020 United States presidential election has been especially divisive with little productive dialogue. The title text might also be a reference to the movie Airplane! (directly referencing the 1957 movie Zero Hour!) where one of the most popular gags is when Steve McCroskey first says "Looks like I picked the wrong week to quit smoking", then "Looks like I picked the wrong week to quit amphetamines", "Looks like I picked the wrong week to quit sniffing glue" and so on.

Randall has also mentioned "screen time apps" in 2223: Screen Time. Randall has previously remarked on poor time allocation in 1445: Efficiency, in which he admits that he reduces his overall efficiency by spending too much time figuring out which approach to a problem was more efficient.

In 2282: Coronavirus Worries, he indicated that worrying about other people's actions is much less healthy (although unfortunately more common) than looking after your own health.



## #2372: Dialect Quiz

October 14, 2020

### DIALECT QUIZ

COMPARE ANSWERS WITH YOUR FRIENDS!

HOW DO YOU ADDRESS A GROUP OF TWO OR MORE PEOPLE?

- A) YOU
- B) YALL
- C) I HAVE NOT BEEN AROUND TWO OR MORE PEOPLE FOR SO LONG THAT I CAN'T REMEMBER

HOW DO YOU PRONOUNCE "PENELOPE"?

- A) RHYMES WITH "ANTELOPE"
- B) RHYMES WITH "DEVELOP"

WHAT DO YOU CALL THE SCIENTIFIC FIELD THAT STUDIES THE STARS?

- A) ASTROLOGY
- B) AGRONOMY
- C) COSMETOLOGY

HOW DO YOU PRONOUNCE "GENRE"?

- A) GONE-RA
- B) JUH-NEER
- C) JEN-ER-UH

DO YOU PRONOUNCE "GOOGLE" WITH A HIGH-PITCHED YELP ON THE...

- A) FIRST SYLLABLE
- B) SECOND SYLLABLE

WHAT DO YOU CALL THE THING ON THE WALL AT SCHOOL THAT YOU DRINK WATER FROM?

- A) GUTTER PIPE
- B) DRAINPIPE

HOW DO YOU PRONOUNCE THE NAME FOR A SHORT SILENT VIDEO FILE?

- A) ANIMATED GIVE
- B) ANIMATED GIFT

WHAT DO YOU CALL THE BASEBALL-SIZED GARDEN BUGS THAT, WHEN POKED, GLOW BRIGHTLY AND EMIT A WARBLING SCREAM?

- A) WHAT?
- B) LAWN BUDDIES

WHAT DO YOU CALL THE MISLEADING LINES PAINTED BY DISGRUNTLED HIGHWAY WORKERS TO TRICK CARS INTO DRIVING OFF THE ROAD?

- A) PRANK LINES
- B) DEVIL'S MARKS
- C) FOOL-ME LINES
- D) FAUXGUIDES
- E) DELAWARE LINES

WHAT DO YOU CALL THE BLUE-GREEN PLANET IN THE OUTER SOLAR SYSTEM?

- A) URANUS
- B) NEPTUNE

WHAT DO YOU CALL THIS TOOL?



- A) BANGER
- B) NAIL AXE
- C) WOOD MAGE WAND
- D) I'M FAMILIAR WITH THIS TOOL BUT HAVE NO SPECIFIC WORD FOR IT
- E) I HAVE NEVER SEEN IT BEFORE

WHAT DO YOU CALL A LONG SANDWICH WITH MEATS AND LETTUCE AND STUFF?

- A) A LONG SANDWICH WITH MEATS AND LETTUCE AND STUFF
- B) A LONGWICH
- C) A SALAD HOT DOG

WHAT DO YOU CALL THE SCALY MANY-LEGGED ANIMAL OFTEN FOUND IN ATTICS?

- A) LIGHTBULB EATER
- B) I HAVE NO SPECIAL NAME FOR THEM
- C) I'VE NEVER LOOKED IN MY ATTIC

WHAT DO YOU SAY WHEN SOMEONE AROUND YOU SNEEZES?

- A) "WHAT WAS THAT?"
- B) "OH, WOW!"
- C) [QUIETLY] "YIKES"

Do you make a distinction between shallots, scallops, and scallions? If you use all three words, do they all have different meanings, all the same, or are two the same and one different?

## Explanation

This comic is a parody of online quizzes that offer to compare the user's dialect of American English with others around the country. These quizzes generally contain questions about word usage, names for certain objects, and pronunciations that vary between different regions of the US. There are also quizzes about broader English dialects, but this comic focuses on commonly cited differences between American dialects.

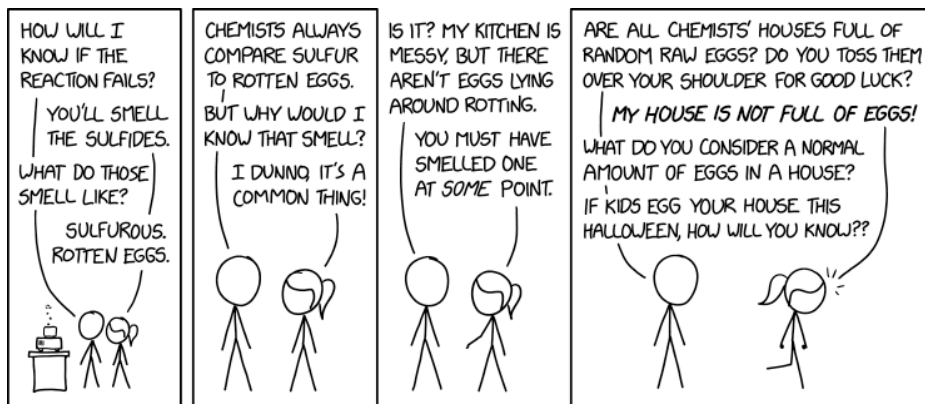
The earliest quiz of this type to be widely disseminated online was the Harvard Dialect Survey, conducted in the early 2000s by Bert Vaux and Scott Golder. The survey created maps of the distribution of various word usage (such as pop/soda/coke for a fizzy softdrink) and was a relatively early example of widely shared Internet "viral" content. In 2013, Josh Katz of the New York Times created a new version based on the Harvard survey, which became the Times' most popular content of 2013 and spread the idea to many more people. Many of the questions in this comic directly derive from entries in those surveys.

Randall's previous two comics have been about election predictions, leading up to the 2020 US General Presidential Election. A prominent predictor of the election results is Nate Silver, who runs the FiveThirtyEight website. He posted his results of taking the New York Times version of the survey on October 11, 2020, just three days before this comic was posted.

2371: Election Screen Time specifically suggests that Randall may be spending too much time obsessing over new posts and content from the election predictors. It's coincidental, but likely, that Nate Silver's tweet inspired Randall's post: he was reminded of the 2013 feature from the Times.

## #2373: Chemist Eggs

October 16, 2020



Chemists actually find it simpler to define a general odor of rotten eggs as a baseline, and the **LACK** of rotten eggs as a distinct smell.

## Explanation

In this comic, Ponytail explains to Cueball that if he smells sulfides then the chemistry experiment on which they're working has failed. Ponytail then clarifies that sulfides smell like rotten eggs. The main and most distinct chemical rotten eggs emit is hydrogen sulfide, hence most people who smell them will link the chemical with "rotten egg smell".

Cueball replies, however, that he doesn't actually know what rotten eggs smell like, and it's odd that everyone uses that as a comparison. This is a result of changing times — decades ago, when the 'rotten eggs' descriptor became commonplace in chemistry education at high schools and universities, rotten eggs were indeed common enough that cooks avoided adding eggs directly to other ingredients, lest the rotten egg, not detected until after it was too late, force the cook to discard everything and start over. Vastly improved farming, shipping, and marketing practices have made the rotten egg vanishingly rare, at least at supermarkets in the USA. Moreover, much greater recognition of the health hazards of hydrogen sulfide means that, due to various occupational safety precautions, opportunities for sniffing the gas have become scarce, and usually engender swift reactions such as building evacuation.

Thus, the comparison has outlived the circumstances that spawned it, and chemistry teachers parrot a line they learned as students, which is no longer relevant to the

students' experience. Cueball then takes the disconnect between the trope and his experience and pushes it for all it's worth. This could be taken as symbolic of people who spot such discordances and blow them out of proportion to troll others, in which case, Cueball has most definitely succeeded, based on how Ponytail reacts — she is clenching her fists in anger as she leaves the conversation, presumably to avoid further irritation. (Perhaps she smells eggs often from the people in 382: Trebuchet!)

Some of Cueball's questions suggest that chemists use eggs in place of other items. For example, the superstitious may react to a spilling of salt by picking it up and throwing it over their left shoulder, ostensibly as an attempt to blind the Devil. Another relates to the upcoming night before Halloween event called "Mischievous Night", where kids are known to throw eggs at houses. Cueball asks Ponytail how she will know if this has happened, as he thinks she keeps an unusually large number of eggs in her house.

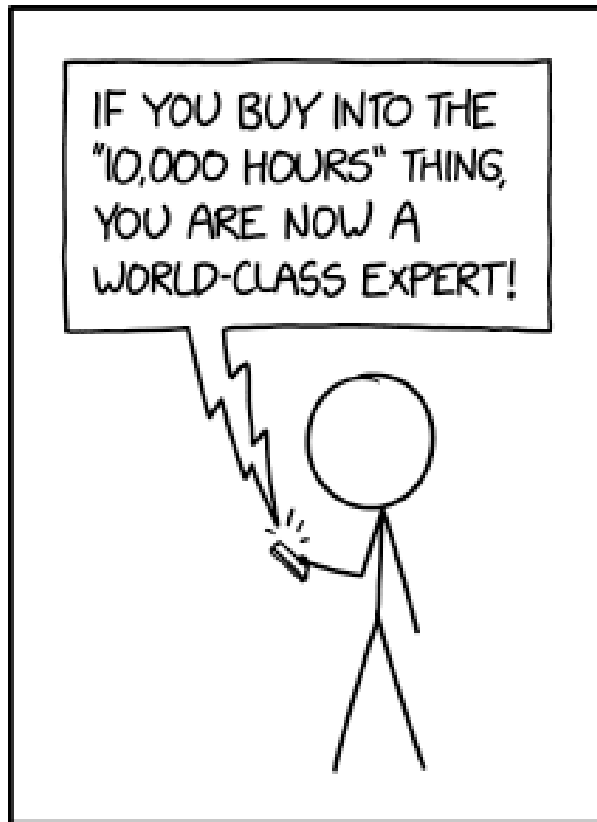
Even though rotten eggs (and hydrogen sulfide in general) are much less common nowadays, many fuel gases are mixed with odorant compounds to signal that a leak is happening; even if the user might be unfamiliar with "rotten eggs" specifically, a large amount of unpleasant odor still works as an alarm that something bad is happening. People who use natural gas or propane stoves should be familiar with the similarly rotten smell of methanethiol, ethanethiol, and/or tert-butylthiol (the "-SH" thiol group is a common feature of many pungent

odors, including garlic and skunk spray). Some mineral springs and other natural water sources also contain sulfides and have a strong sulfide odor and flavor; they are sometimes referred to as "sulfur springs".

The title text makes a joke about how often chemists use the comparison, saying that they use a rotten egg smell as the baseline and that a lack of the smell is a distinct one. Given the health hazards of hydrogen sulfide and the regulations now enforced in recognition of those hazards, the chemistry teacher probably doesn't often experience the smell either. Since hydrogen sulfide deadens the sense of smell, taking this smell as a 'baseline' is improbable and potentially dangerous, and it's unfortunate that the title text makes this suggestion.

## #2374: 10,000 Hours

*October 19, 2020*



MY SCREEN TIME REPORTS  
HAVE STARTED TRYING TO PUT  
A POSITIVE SPIN ON THINGS.

I'm proud to announce that as of this year I've become a world-class expert at chewing.



## Explanation

Popular smartphone operating systems automatically record the amount of time the user spends using their phone, broken down by time spent in each app. This feature is supposed to allow users to analyze their own habits. On iOS, this feature is called Screen Time. On Android, it is called Digital Wellbeing. Such analyses are typically presented to show users how much time they spend on their devices, with the implication that they should spend less time on screens. Accordingly, higher amounts of time on a device can give feelings of guilt and unhappiness.

This comic inverts the idea by referencing "the 10,000 hours thing". This is a (somewhat dismissive) reference to the notion that at least 10,000 hours of practice are required to become an expert in any given field. This notion was popularized by Malcolm Gladwell in the book "Outliers", and has frequently been misunderstood to imply that anyone who practices anything for 10,000 hours will become an expert.

In this comic, Cueball's phone tells him that, assuming that the 10,000-hour idea is correct, he is now an expert, implying that he's spent 10,000 cumulative hours on his phone. The 10,000-hour refrain usually pertains to skill-based tasks, such as arts or athletics. Spending time on one's phone requires almost no skill, and it's unlikely that he spent all, or even most of that time focused on a particular set of skills. The joke is that Cueball has spent

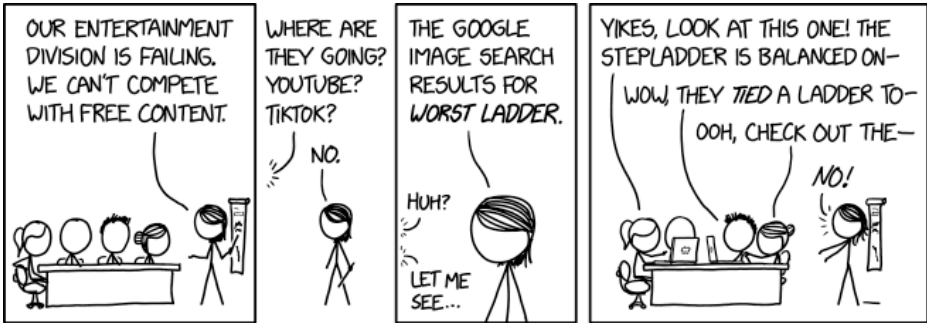
a huge amount of time on largely frivolous activities, and has now become a "world-class expert" in browsing, playing and texting on his phone.

Randall often pokes fun at his extensive screen time, such as in 2223: Screen Time.

The title text refers to the fact that people eat a lot, 1-2 hours a day, though not all of this time is spent chewing. At the time of this comic's publication, Randall was just over 36 years old (13,151 days), so he has spent a large amount of time eating, well over 10,000 hours. It could also be a reference to the comic strip Calvin and Hobbes (which has been referenced before), in which Calvin refers to routines he has created to improve at chewing.

## #2375: Worst Ladder

October 21, 2020



[Six months later] "Well, our 'worst ladder' subscription series was a surprisingly lucrative success, but was completely canceled out by the losses from the disastrous Home Depot merchandising tie-in."

## Explanation

An always present concern of media industries is consumers shifting tastes or indeed abandoning a medium altogether (such as print newspapers or in-person theaters). This strip depicts one such scenario prompting a meeting to discuss the problem. The other attendees suspect the consumers are simply shifting to an online platform, but Megan reveals they are instead shifting towards image search results.

Of course, during the age of the internet, there are many sources of free entertainment. YouTube and TikTok provide examples of these services, as practically anyone can choose from a tremendous variety of content. Therefore, this abundance of free content hurts services that require money to see their content, particularly when this content does not have any factors that make it inherently more appealing than the free services. The Quibi paid service shut down, just 6 months after it opened, on the same day that this comic appeared.

The joke here is that instead of YouTube or TikTok, possible customers are going to the Google Image search page for "worst ladder". Even the meeting participants are entranced by it, so the meeting devolves into everyone showing their favorites to each other, even though everyone there should have a particularly vested interest in their own company's performance.

Searching for images is an unorthodox source of

entertainment, frequently only seen when searching for memes (this, in fact, is how Know Your Meme gauges interest in a meme). Depending on your relationship with Google's personalization algorithms, image results may change up between different people or different views, or remain roughly stagnant from day to day (contrasted with other services that contain new posts nearly every second), and the quality of any Google Images page will decline with scrolling. Therefore, an image search results page is not a sustainable source of entertainment,[citation needed] and may be unlikely to compete with the service in this comic.

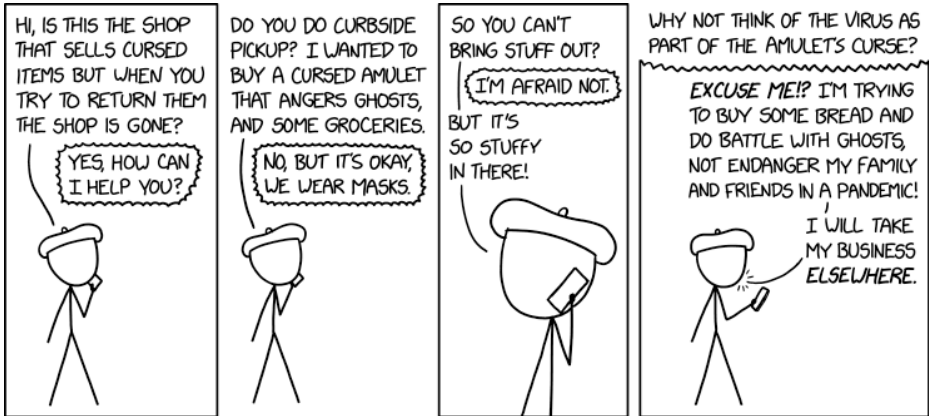
Search results currently tend to vary widely from person to person, as Google uses the user's search history, IP address, and location to try to find the most relevant result for each person, even if they are not logged in. (For instance, regular readers of xkcd are more likely to see this comic in the search results for "worst ladder".) This provides social opportunities around searching, sometimes exploited by social media posts (which may be how Megan originally found out).

The title text explains that the company actually decided to use the idea, and created a subscription service for these images. The idea was a success and was indeed very lucrative. They then tried selling actual "worst ladders", or "worst ladders"-themed merchandise at a hardware store, thinking that people who enjoy looking at others' mistakes would also enjoy making that mistake themselves, but this tie-in ended up costing them as much money as they made from the subscriptions (if the

word "disastrous" is meant literally, there may have been injuries and liability lawsuits involved). Alternately, those who happily consumed this company's new output were put off by the overt commercialism of over-promoting the chain-store and so took their schadenfreude custom somewhere else/back to their original ad hoc sources.

## #2376: Curbside

October 23, 2020



The state has had so many contact tracers disappear into that shop that they've had to start a contact tracer tracing program.

## Explanation

This comic is another in a series of comics related to the COVID-19 pandemic.

Beret Guy is making contact with a shop that sells cursed items, only to vanish when the customer tries to return the product. He has previously mentioned doing most of his shopping (including groceries) at such locations in 1772: Startup Opportunity, and visited one (possibly the same one) several months earlier in 2332: Cursed Chair. That visit ended with him trying to stop the COVID-19 pandemic by destroying the cursed chair, but evidently he either failed to destroy the chair (which claimed to be immortal) or found that doing so didn't halt the pandemic. (Apparently Beret Guy has visited this same store before, since he says that "it's so stuffy in there", but has not attempted to return any of his purchases, since the store has not disappeared yet. Or perhaps it is simply nonexistent when someone is trying to return something.)

After confirming that he has the right number, Beret Guy asks if the cursed store does curbside pickup, as he intends to place an order for bread and a cursed amulet, but does not wish to go inside during the pandemic. Many grocery stores have started offering such services, allowing a customer to place an order over the phone or online, then receive it outside the store, thus minimizing the interaction with store staff or other customers. Closed spaces are understood to pose a greater risk of



contagion than the outdoors, where wind and sun can mitigate airborne viral particles.

The store's contact replies that no, they do not offer curbside pickup (which makes sense, given that it would likely go against the whole point of a cursed store), but tries to assure Beret Guy that all employees at the location wear masks. (They might be wearing haunted Halloween masks - see the title text of 2367: Masks.) When Beret Guy expresses disappointment at the revelation, complaining about the stuffy air of the shop, the contact advises him to consider the virus as part of the curses that come with their products. Beret Guy gets angry at this -- apparently, he's okay with buying cursed items, but not exposing himself to unacceptable risks of catching COVID-19. Beret Guy promptly proclaims that he will not be doing business with the location if they are going to showcase such an attitude towards the pandemic. It's unclear how he will find another store with similar unusual characteristics, although it has been mentioned that there is an entire industry of these stores.

Beret Guy mentions that he wants to buy an amulet in order to 'do battle with ghosts', which is not an ordinary thing to do given that most people cannot interact directly with ghosts.[citation needed] Perhaps he has a ghost-fighting weapon that he has also bought from the shop, although a more likely explanation (given Beret Guy's peculiarity) seems that he is somehow able to engage in martial combat with them. A common argument for how ghosts can exist is that they are in another dimension; given that Beret Guy has extra

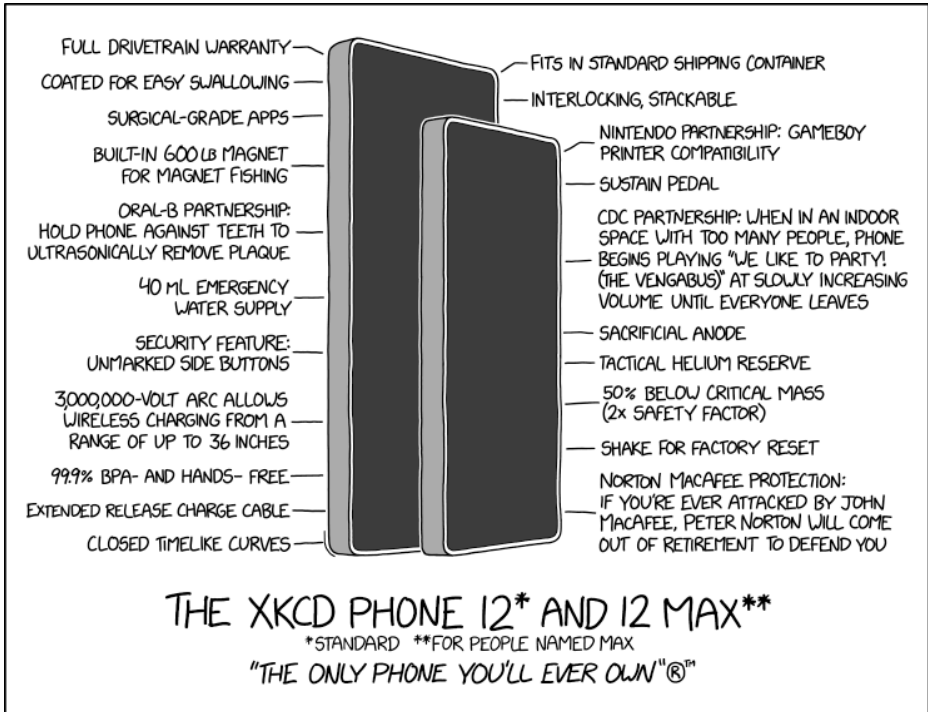
dimensions in his bones (2310: Great Attractor), he might appear as a skeleton warrior in the ghosts' dimension. Thus, being able to battle ghosts would be one of the many strange powers of Beret Guy. It is also unclear why Beret Guy specifically wants to anger the ghosts.

He also mentions that he is there to buy groceries, which is rather ordinary in contrast to the previous request. This is another example of Beret Guy's seemingly oblivious view of the world, putting the purchase of a ghostly amulet on par with buying bread.

The title text explains that contact tracers have been attempting to visit the store to figure out who else has been working or shopping there, which suggests that people may have been exposed to COVID there. However, presumably because of the peculiar nature of the store, a notable number of the contact tracers have not returned from visiting it, leading the state to create a tracing program to find the missing contact tracers. The joke here is that the contact tracers must now be traced by another tracing program. This same kind of recursivity of tracking tracers has been previously explored for finding finders and incinerating incinerators.

## #2377: xkcd Phone 12

October 26, 2020



New phone OS features: Infinite customization (home screen icons no longer snap to grid), dark mode (disables screen), screaming mode (self-explanatory), and coherent ultracapacitor-pumped emission (please let us know what this setting does; we've been afraid to try it).

## Explanation

This is the "12th" (actually the 8th) in the ongoing xkcd Phone series in which Randall explains his new joke phone designs with many strange and useless features. It is also a reference to the recently released iPhone 12. However, there have only been 8 comics released, with the previous two being 2000: xkcd Phone 2000 and 1889: xkcd Phone 6.

The note about the xkcd Phone 12 and the xkcd Phone 12 Max (only for people named Max) is a joke about the different models of iPhone 12: iPhone 12, iPhone 12 Mini, iPhone 12 Pro and iPhone 12 Pro Max. The xkcd Phone 12 Max would be expected to have a larger screen, but it seems that this phone is also only for people with the name Max. If the phones are respectively placed, Max's (Maxes'?) phone is the smaller of the two models.

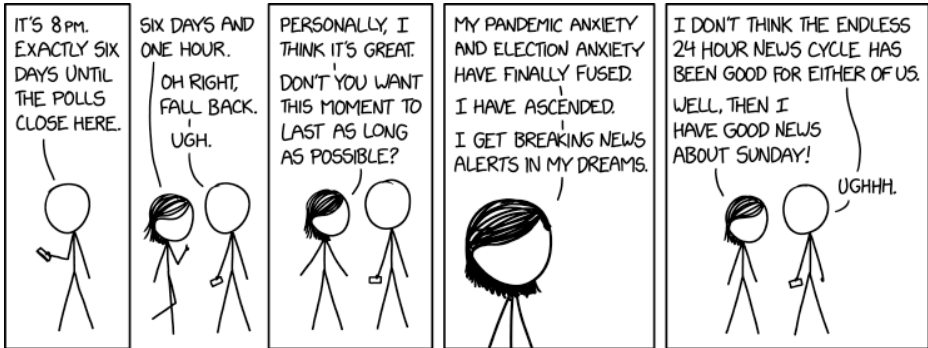
The tagline ""The only phone you'll ever own"" could be interpreted as something of a threat, which is believable given some of the purported features. It is similar to the phrase "The last suit you'll ever wear", describing the black suits worn by the Men in Black in the movie of the same name. The slogan has the "registered trademark" symbol (®), which appears to itself be trademarked, which is highly unlikely.

Multiple features are labelled on the phone that are common when advertising other products, but highly unusual in mobile phones, for comedic effect.

The title text mentions xkcd phone OS updates, including:

## #2378: Fall Back

October 28, 2020



Doing great here in the sixth and hopefully final year of the 2016 election.

## Explanation

Daylight saving time ends in the United States at 2 a.m. on the first Sunday in November, when 2 a.m. becomes 1 a.m. Election Day in the United States is on the Tuesday after the first Monday in November.

In 2020, Nov. 1 is Sunday, so the shift from Daylight Saving Time to Standard Time will happen two days before the 2020 election. This has the effect of making Sunday, Nov. 1 a 25-hour day. The switchover is sometimes referred to mnemonically as "fall back," with its springtime counterpart (a day of 23 hours) being "spring forward" as mentioned in 1655: Doomsday Clock.

At the beginning of the comic, Cueball incorrectly calculates the time until the election day polls close (this varies from state to state); in the second panel, Megan reminds him about falling back. She goes on to possibly sarcastically treasure this extended moment, one more hour to experience the bitter election cycle and the COVID-19 pandemic. Megan describes herself as dissociating here, and it is possible she is actually treating these emergencies as good now, instead of bad. The behavior could be seen as an indirect demand for the situation to change, a demonstration that she may lose her sanity further if it does not. Cueball hears how intense she is saying her experience is, and says he thinks they've both spent too much time engaging with the news (a sentiment echoed from other recent xkcd comics,

like 2371: Election Screen Time and possibly 2374: 10,000 Hours). When he mentions the 24-hour news cycle, Megan corrects him again, as Sunday will be a 25-hour news cycle.

The title text refers to a popular sentiment that the issues and emotions raised in the 2016 United States presidential election were not settled when the election was over and have continued unabated since then. Even though the election itself was held in November 2016, the primary candidates officially announced their campaigns in early 2015; thus, 2020 is the sixth year since that campaign season opened. The implication could be that the whole nation, or at least Randall's community of political followers, has had to be in an altered state of consciousness to handle the past six years. It could also be a reference to ongoing strong campaigning, in excess of what people have seen in the past.



# #2379: Probability Comparisons

October 30, 2020

## PROBABILITY COMPARISONS

0.01%	YOU GUESS THE LAST FOUR DIGITS OF SOMEONE'S SOCIAL SECURITY NUMBER ON THE FIRST TRY	37%	LEBRON JAMES GETS TWO FREE THROWS BUT MISSES ONE
0.1%	THREE RANDOMLY-CHOSEN PEOPLE ARE ALL LEFT-HANDED	40%	A RANDOM SCRAMBLE TILE IS A LETTER IN "STEPH CURRY"
0.2%	YOU DRAW 2 RANDOM SCRAMBLE TILES AND GET M AND M	46%	THERE'S A MAGNITUDE 7 QUAKE IN LA WITHIN 30 YEARS
0.3%	YOU GUESS SOMEONE'S BIRTHDAY AND THEY'RE ALL RED	48%	MILWAUKEE HAS A WHITE CHRISTMAS
0.5%	AN NBA TEAM DOWN BY 30 AT HALFTIME WINS	50%	A RANDOM SCRAMBLE TILE IS A LETTER IN "CARLY RAE JEPSEN"
1%	YOU GET 4 M&M'S AND THEY'RE ALL BROWN OR YELLOW	53%	YOU GET HEADS IN A COIN TOSS
1.5%	STEPH CURRY GETS TWO FREE THROWS AND MISSES BOTH	54%	SALT LAKE CITY HAS A WHITE CHRISTMAS
2%	LEBRON JAMES GUESSES YOUR BIRTHDAY IF EACH GUESS COSTS ONE FREE THROW AND HE LOSES IF HE MISSES	58%	LEBRON JAMES GETS TWO FREE THROWS AND MAKES BOTH
2.1%	YOU GET TWO M&M'S AND THEY'RE BOTH RED	58%	A RANDOM SCRAMBLE TILE IS A LETTER IN "MATE SILVER"
2.2%	YOU SHARE A BIRTHDAY WITH A BACKSTREET BOY	60%	YOU GET TWO M&M'S AND NEITHER IS BLUE
3%	YOU GUESS SOMEONE'S CARD ON THE FIRST TRY	65%	BURLINGTON, VERMONT HAS A WHITE CHRISTMAS
3.1%	YOU GUESS 5 COIN TOSSES AND GET THEM ALL RIGHT	66%	A RANDOMLY CHOSEN MOVIE FROM THE MAIN LORD OF THE RINGS TRILOGY HAS "OF THE" IN THE TITLE TWICE
4%	STEPH CURRY WINS THAT BIRTHDAY FREE THROW GAME	67%	YOU ROLL AT LEAST A 3 WITH A D6
4.1%	YOU SUEEP A 3-GAME ROCK PAPER SCISSORS SERIES	71%	A RANDOM SCRAMBLE TILE BEATS A RANDOM DICE ROLL
4.2%	PORTLAND OREGON HAS A WHITE CHRISTMAS	73%	LEBRON JAMES MAKES A FREE THROW
5%	YOU SHARE A BIRTHDAY WITH TWO US SENATORS	75%	YOU DROP TWO PLAIN M&M'S AND ONE OF THEM LANDS WITH THE "T" UP SO IT'S CLEAR THEY'RE NOT SKITTLES
5.1%	AN NBA TEAM DOWN BY 20 AT HALFTIME WINS	76%	YOU GET TWO M&M'S AND NEITHER IS RED
6%	YOU ROLL A NATURAL 20	77%	YOU GET AN M&M AND IT'S NOT BLUE
6.1%	YOU CORRECTLY GUESS SOMEONE'S CARD GIVEN 3 TRIES	77%	AN NBA TEAM WINS WHEN THEY'RE UP 10 AT HALFTIME
7%	LEBRON JAMES GETS TWO FREE THROWS AND MISSES BOTH	79%	ST. LOUIS DOESN'T HAVE A WHITE CHRISTMAS
8%	YOU CORRECTLY GUESS SOMEONE'S CARD GIVEN 4 TRIES	81%	TWO RANDOM PEOPLE ARE BOTH RIGHT-HANDED
9%	STEPH CURRY MISSES A FREE THROW	83%	STEPH CURRY GETS TWO FREE THROWS AND MAKES BOTH
10%	YOU DRAW 5 CARDS AND GET THE ACE OF SPADES	85%	YOU ROLL A D20 AND GET AT LEAST 4
10.1%	THERE'S A MAGNITUDE 8+ EARTHQUAKE IN THE NEXT MONTH	87%	AN NBA TEAM UP BY 10 GOING INTO THE 4TH QUARTER WINS
12%	A RANDOMLY-CHOSEN AMERICAN LIVES IN CALIFORNIA	87%	SOMEONE FAILS TO GUESS YOUR CARD GIVEN 7 TRIES
12.1%	YOU CORRECTLY GUESS SOMEONE'S CARD GIVEN 6 TRIES	88%	A RANDOMLY CHOSEN AMERICAN LIVES OUTSIDE CALIFORNIA
13%	YOU SHARE A BIRTHDAY WITH A US PRESIDENT	89%	YOU ROLL A 3 OR HIGHER GIVEN TWO TRIES
13.1%	A D6 BEATS A D20	90%	SOMEONE FAILS TO GUESS YOUR CARD GIVEN 5 TRIES
14%	AN NBA TEAM DOWN 10 GOING INTO THE 4TH QUARTER WINS	91%	YOU INCORRECTLY GUESS THAT SOMEONE WAS BORN IN AUGUST
15%	YOU PULL ONE M&M FROM A BAG AND IT'S RED	92%	STEPH CURRY MAKES A FREE THROW
16%	A RANDOMLY DRAWN SCRAMBLE TILE BEATS A D6 DIE ROLL	93%	YOU GUESS SOMEONE'S BIRTH MONTH AT RANDOM AND ARE WRONG
17%	YOU ROLL A D20 AND GET AT LEAST 18	94%	LEBRON JAMES MAKES A FREE THROW GIVEN TWO TRIES
18%	STEPH CURRY GETS TWO FREE THROWS BUT ONLY MAKES ONE	94%	SOMEONE FAILS TO GUESS YOUR CARD GIVEN 3 TRIES
19%	YOU ROLL A D6 DIE AND GET A 6	95%	AN NBA TEAM WINS WHEN THEY'RE UP 20 AT HALFTIME
20%	A D6 BEATS OR TIES A D20	96%	SOMEONE FAILS TO GUESS YOUR CARD GIVEN 2 TRIES
21%	AT LEAST ONE PERSON IN A RANDOM PAIR IS LEFT-HANDED	97%	YOU TRY TO GUESS 5 COIN TOSSES AND FAIL
22%	YOU GET A DOZEN M&M'S AND NONE OF THEM ARE BROWN	98%	YOU INCORRECTLY GUESS SOMEONE'S BIRTHDAY IS THIS WEEK
23%	ST. LOUIS HAS A WHITE CHRISTMAS	98.5%	AN NBA TEAM UP 15 POINTS WITH 8 MINUTES LEFT WINS
24%	AN NBA TEAM WINS WHEN THEY'RE DOWN 10 AT HALFTIME	99%	STEPH CURRY MAKES A FREE THROW GIVEN TWO TRIES
25%	YOU GET AN M&M AND IT'S BLUE	99.5%	AN NBA TEAM THAT'S UP BY 30 POINTS AT HALFTIME WINS
26%	YOU SHARE A BIRTHDAY WITH A US SENATOR	99.7%	YOU GUESS SOMEONE'S BIRTHDAY AT RANDOM AND ARE WRONG
27%	YOU CORRECTLY GUESS THAT SOMEONE WAS BORN IN THE WINTER	99.8%	THERE'S NOT A MAGNITUDE 8 QUAKE IN CALIFORNIA NEXT YEAR
28%	YOU ROLL TWO PLAIN M&M'S AND GET M AND M	99.9%	A RANDOM GROUP OF THREE PEOPLE CONTAINS A RIGHT-HANDER
29%	YOU CORRECTLY GUESS SOMEONE WAS BORN IN THE FALL	99.99%	YOU INCORRECTLY GUESS THE LAST FOUR DIGITS OF SOMEONE'S SOCIAL SECURITY NUMBER
30%	YOU CORRECTLY GUESS SOMEONE WAS BORN IN THE SUMMER	99.999%	YOU PICK UP A PHONE, DIAL A RANDOM 10-DIGIT NUMBER, AND SAY "HELLO BARACK OBAMA, THERE'S JUST BEEN A MAGNITUDE 8 EARTHQUAKE IN CALIFORNIA" AND ARE WRONG
31%	LEBRON JAMES MISSES A FREE THROW	99.9999%	YOU ADD "HANG ON THIS IS BIG—I'M GOING TO LOOP IN CARLY RAE JEPSEN," DIAL ANOTHER RANDOM 10-DIGIT NUMBER, AND SHE PICKS UP
32%	PITTSBURGH HAS A WHITE CHRISTMAS		
33%	A RANDOMLY CHOSEN SEAR WILKS MOVIE (EPISODES 1-10) HAS "OF THE" IN THE TITLE		
34%	YOU WIN THE MONTY HALL SPORTS CAR BY PICKING A DOOR AND REFUSING TO SWITCH		
35%	YOU LOSE THE MONTY HALL SPORTS CAR BY PICKING RANDOMLY		
36%	YOU DRAW 5 CARDS AND GET AN ACE		
37%	A RANDOM SCRAMBLE TILE IS ONE OF THE LETTERS IN "RANDOM"		

SOURCES: K&CD.COM/2379/SOURCES

Call me, MAYBE.

## Explanation

This is a list of probabilities for different events. There are numerous recurring themes, of which the most common are free throws (13 entries), birthdays (12), dice (12, split about evenly between 6-sided (d6) and 20-sided (d20) types), M&M candies (11), playing cards (9), NBA basketball mid-game victory predictions (9), Scrabble tiles (7), coins (7), white Christmases (7) and the NBA players Stephen Curry plus LeBron James (7 each). Themes are variously repeated and combined, for humorous effect. For instance, there are entries for both the probability that St. Louis will have a white Christmas (21%) and that it will not (79%). Also given is the 40% probability that a random Scrabble tile will contain a letter from the name "Steph Curry". There are 80 items in the list, the last two of which devolve into absurdity - perhaps from the stress of preparing the other 78 entries.

The list may be an attempt to better understand probabilistic election forecasts for the 2020 United States presidential election, which was four days away at the time this comic was published and had also been alluded to in 2370: Prediction and 2371: Election Screen Time. Statistician and psephologist Nate Silver is referenced in one of the list items. On the date this cartoon was published, Nate Silver's website FiveThirtyEight was publishing forecast probabilities of Donald Trump and Joe Biden winning the US Presidential election. On 31 October 2020, the forecast described the chances of Donald Trump winning as "roughly the same as the

chance that it's raining in downtown Los Angeles. It does rain there. (Downtown L.A. has about 36 rainy days per year, or about a 1-in-10 shot of a rainy day.)" A day previously, when the chances were 12%, the website had also described Trump's chances of winning as "slightly less than a six sided die rolling a 1". The probabilities are calculated from these sources, as mentioned in the bottom left corner of the comic.

The title text refers to the song "Call Me Maybe" by Carly Rae Jepsen (cited twice in the list). "MAYBE" is emphasized, perhaps because the probability of getting her phone number correct, as in the last item in the list, is very low. The capitalization could also be a reference to Scrabble tiles, as was previously mentioned in association with Carly Rae Jepsen.

# #2380: Election Impact Score Sheet

November 02, 2020

## DO YOU KNOW ANYONE IN ARIZONA?

RESEARCH SHOWS THAT REMINDERS FROM FRIENDS AND FAMILY TO VOTE HAVE A BIGGER EFFECT ON TURNOUT THAN ANYTHING CAMPAIGNS DO.

ONE OF THE BEST WAYS YOU CAN HELP IS TO SCROLL THROUGH YOUR CONTACTS (OR USE APPS LIKE VOTEWITHME) TO FIND PEOPLE YOU CAN CHECK IN WITH TO SEE IF THEY PLAN TO VOTE OR NEED HELP DOING IT.

THIS CHART LETS YOU TALLY THE EFFECT OF YOUR REMINDERS ON THE OUTCOME BASED ON WHO YOU'VE CONTACTED AND WHERE THEY LIVE.

## ELECTION IMPACT SCORE SHEET

STATE	CHECK-INS	BONUS* POINTS	
PENNSYLVANIA		x5	
MAINE ARIZONA NEVADA		x4	
ALASKA MONTANA NEW MEXICO		x3	
WISCONSIN MINNESOTA IOWA NORTH CAROLINA NEW HAMPSHIRE GEORGIA NEBRASKA		x2	
MICHIGAN FLORIDA KANSAS MISSISSIPPI COLORADO		x1	
ALL OTHER STATES		x½	

YOUR ELECTION IMPACT:

\*MULTIPLIER BASED ON 538 PRESIDENTIAL VOTE IMPACT, PLUS POINTS FOR SENATE AND LOCAL ELECTIONS

STATE	CHECK-INS	BONUS* POINTS
PENNSYLVANIA	11	x5 10
MAINE ARIZONA NEVADA	1	x4 4
ALASKA MONTANA NEW MEXICO	1	x3 3
WISCONSIN MINNESOTA IOWA NORTH CAROLINA NEW HAMPSHIRE GEORGIA NEBRASKA	111	x2 6
MICHIGAN FLORIDA KANSAS MISSISSIPPI COLORADO		x1
ALL OTHER STATES	1111	x½ 3
YOUR ELECTION IMPACT:		26

BASED ON TURNOUT EXPERIMENTS, 10 POINTS ON THIS SCALE HAS ROUGHLY AS MUCH EFFECT ON THE OUTCOME AS ONE AVERAGE VOTE.

FOR EVERY 10 POINTS YOU TALLY, IT'S AS IF YOU VOTED AGAIN!

[CLICK FOR PRINTABLE VERSION]

SHARE A PIC OF YOUR SCORE SHEET WITH #HASHTAG, AND BE SURE TO SEND A COPY TO NATE SILVER TO LET HIM KNOW TO INCLUDE THOSE EXTRA VOTES IN HIS MODEL!

You might think most people you know are reliable voters, or that your nudge won't convince them, and you will usually be right. But some small but significant percentage of the time, you'll be wrong, and that's why

this works.

## Explanation

This comic was published the day before Election day in the United States (November 3, 2020), which features a contentious presidential election between the incumbent, President Donald Trump, and the challenger, former Vice President Joe Biden. The United States does not elect presidents by popular vote, but instead uses an electoral college system, with each state getting a predetermined number of electoral votes, and a majority of electoral votes needed to win an election. The previous presidential election in 2016, which involved Trump and Hillary Clinton, was won by Trump, who lost the popular vote by 2 percentage points, but won the electoral vote 304-227 (270 was needed to win the election).

Electoral college votes are distributed based on the number of congressional representatives of each state, with the most populous state, California, receiving 55 votes, and the least populous states which are Alaska, Delaware, Montana, North Dakota, South Dakota, Vermont, and Wyoming receiving 3 votes each, along with the District of Columbia, which as of the writing of this comic was not a state. Because the United States Congress has two legislative houses, with only one (the House of Representatives) apportioning representatives to the states based on their percentage of the US population and the other (the Senate) allocating two senators to every state regardless of population, smaller states have a higher ratio of electoral college votes to

population than larger states do.

Additionally, most states (all but Nebraska and Maine) give all of their electoral college votes to whoever earns the most votes in their state. This means that a small change in the percentage of voters who favor one party's candidate over another within a state doesn't make a difference on the final outcome unless that change tips the scales between the two candidates. Therefore, it's easy to predict the final electoral college votes of many states where one party has a clear lead. Other states, including some of the ones listed by Randall, are considered "swing states", as they are competitive to both of the two major parties, the Republican Party and the Democratic Party.

Together, these factors make voting in some states - "swing states" with smaller populations - much more likely to influence the outcome of the election than others. Randall in this comic is encouraging his readers to "get out the vote" and encourage voting among their friends and family who live in these nineteen states which are most likely to affect the outcome of the election. The rest of the 31 states (and, presumably, the District of Columbia) are grouped under the "all other states" bucket, presumably as their election outcome is "safely" for Biden or Trump.

Per many analysts, the state of Pennsylvania is considered an absolute necessity for Trump, and considered very important for Biden. This is why Pennsylvania is weighted the most heavily in Randall's comic.

Of course, just because a state may be a clear win for one party does not mean the votes of anyone who votes for the other party are wasted. A higher percentage of voters voting for the losing candidate sends a signal that the state is more competitive than assumed, which forces representatives to compromise and could make future voters more likely to show up because they believe their vote is more likely to matter. Additionally, many "down-ballot" races, like races for governorships, US Congress, state legislatures, and county governments, may be more competitive than the presidential race, and may have just as much or more impact on most people's lives. Randall accounts for some of these local races in deciding how to rank the states on the scoresheet.

The text at the bottom says to post your scoresheet with #Hashtag. The "#" symbol (pronounced "hash") denotes a hashtag on platforms like Twitter, used to tag one's post as relating to the topic named following the symbol. However, this hashtag (said out-loud as "Hashtag Hashtag") would relate a post to the topic of hashtags rather than elections or votes, and so for the scoresheet is nonsensical and doesn't describe anything useful. It also refers to Nate Silver's famous election forecast model at FiveThirtyEight. Randall closes by urging people to contact Nate Silver to tell him to adjust his model to account for the added votes they have caused, but as the form doesn't indicate which candidate the filler has voted for or plans to vote for, never mind the people contacted, there's no way for him to know what sort of update to make. Perhaps the flurry of posts bearing the hashtag



"#Hashtag" and indicating an effort to increase civic engagement will be a heartwarming surprise on a day that will probably be very busy and stressful for him.

The title text explains that even if one thinks that their family and friends always vote, or that their reminder to vote won't work, they should do so anyway because of the chance they may be wrong.

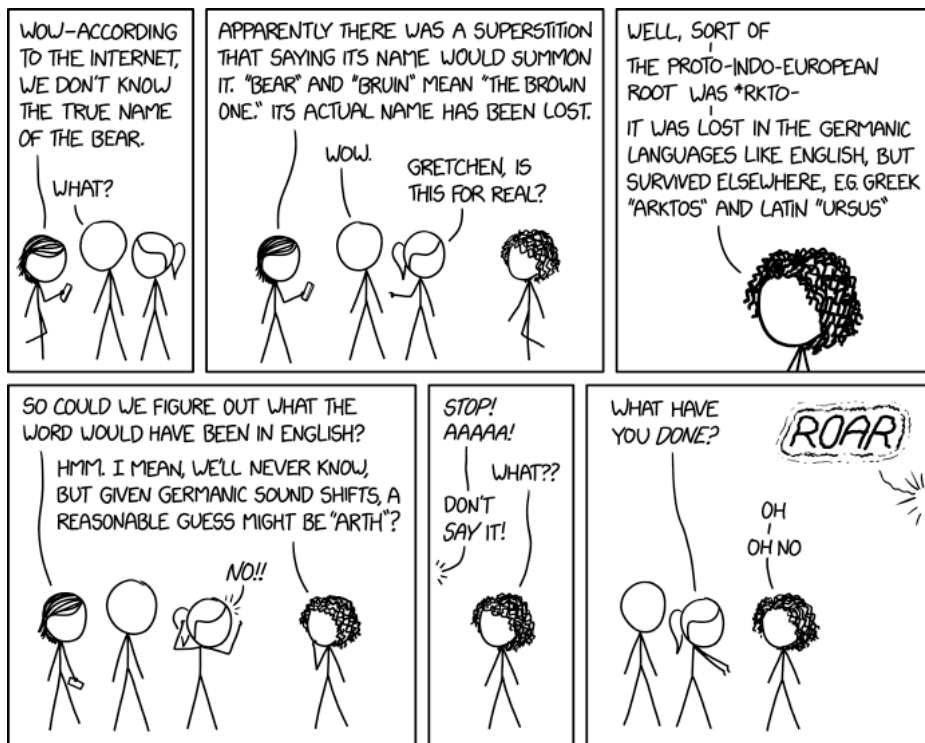
As shown in previous comics (1756: I'm With Her and others), Randall was a supporter of 2016 candidate Hillary Clinton (who ran against Trump), but this announcement should be equally applicable to supporters of either of the two main candidates in the current presidential race.

### **Table[edit]**

As for all other states: President Trump won Alabama, Arkansas, Idaho, Indiana, Kentucky, Louisiana, Missouri, North Dakota, Ohio, Oklahoma, South Carolina, South Dakota, Tennessee, Texas, Utah, West Virginia, and Wyoming; while former Vice President won California, Connecticut, Delaware, the District of Columbia, Hawaii, Illinois, Maryland, Massachusetts, New Jersey, New York, Oregon, Rhode Island, Virginia, Vermont, and Washington.

## #2381: The True Name of the Bear

November 04, 2020



Thank you to Gretchen McCulloch for fielding this question, and sorry that as a result the world's foremost internet linguist has been devoured by the brown one. She will be missed.

## Explanation

The Canadian Internet linguist Gretchen McCulloch tweeted about the theory that the word for bear became taboo in some branches of Indo-European languages - notably the Germanic one - and it was replaced by euphemisms. In the Germanic branch, the euphemism may have been "the brown one," and thus the modern word "bear" (derived from Germanic "beran") would more literally translate into the color "brown" rather than the animal.

The Indo-European word for bear is  $*h_2r̥tkos$  (given in the comic as the root  $*rkto-$ , a later form of the root) which has been inferred from modern languages that still use a word derived from it. In the comic, McCulloch applies sound shifting laws to it to guess how it would have evolved in English had it not been superseded, but saying it seems to actually summon a bear.

(The asterisk is used by linguists to mark a word that doesn't currently exist in a spoken language - in this case, because it's a reconstructed ancestor to modern words in a number of languages.)

Interestingly enough, the hypothesized word "arth" is the same as the Welsh and Cornish for the word "bear." Welsh belongs to the Celtic language family, which is one of the Indo-European branches that still uses a word derived from  $*h_2r̥tkos$ , as do the Italic (Romance), Greek and Indo-Aryan (Sanskrit) branches, while Germanic,

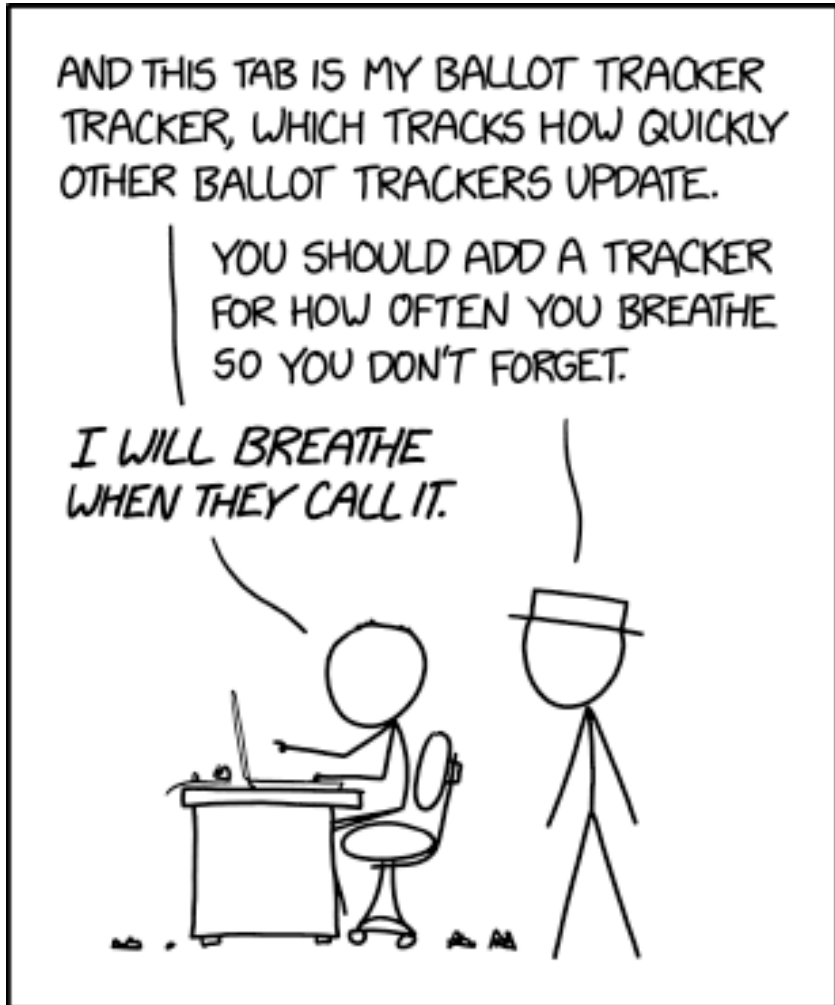
Slavic and Baltic branches abandoned it for different euphemisms. Another Indo-European language where the word for bear is very close to this extrapolation is Armenian, where it's written and pronounced "artch". The comic does not explain why speakers of Welsh, Cornish, Italic, Greek, Indo-Aryan, and Armenian languages do not summon a bear every time they refer to one.[citation needed]

Linguists on Tumblr have observed that "arth" is not actually how the Indo-European root for 'bear' would have emerged in English; "orx" or "orse" is a more likely hypothesis.

Use of true names appears to be highly effective in the xkcd universe, rather like a fairy tale, and it is also a common trope elsewhere. Some say a true name contains clear meaning of who someone or something really is. Gretchen McCulloch has been mentioned in 2250: OK/okay/ok. In later comics, Gretchen is used again, causing annoyance in 2421: Tower of Babel. Since these stories occur during biblical times or in extra-dimensional realities, it is not Gretchen, but obviously this is how linguists look in xkcd from now on.

## #2382: Ballot Tracker Tracker

*November 06, 2020*



Good luck to Democrats in the upcoming Georgia runoff elections, and to the Google Sheets SREs in the current run-on elections.

## Explanation

This comic was posted 3 days after the 2020 election day in the United States (November 3, 2020). As of the date of posting, the 2020 United States presidential election, between President Donald Trump and former Vice President Joe Biden, still had not been "called" for either candidate by most news outlets ("called" refers to projecting the results of the election). This was atypical for most US presidential elections, which were "called" either on election day or on the morning following. A major reason for the delay in determining the results of the election was the greatly increased use of mail-in ballots, caused by social distancing concerns due to the COVID-19 pandemic. Mail-in ballots in some states were counted after the in-person voting, which caused delays in the vote-counting, and thus the projection of the winner. As of the date of posting, the electoral vote counts - as called by most major news organizations - were 253-214 in favor of Biden, with 270 electoral votes needed to win the election. Six states were considered "too close to call", with no determined winner until more ballots were counted. Biden was winning the popular vote by about 4 million.

Cueball in this comic has created an app, doc, or website that tracks in real time how quickly "ballot trackers" update. A ballot tracker is a web page provided by a news organization that reports updated vote counts as they are published by the states. The news organizations use these counts as the major input to the "decision desks", which

are their staff who analyze the ongoing vote results to decide when to declare a projected winner for a state. (See "Tracking Which News Outlets Have Called the Presidential Race in Each State") Cueball (representing Randall) is anxiously awaiting resolution to the long election season. Not only is he anxiously checking to see if the race has been decided, but he is also predicting how close the race is to being decided by constantly checking the ballot trackers to see how they change, as well as keeping track of which sources of tracking information most quickly show updated information on which to base those predictions.

The last line of dialogue in the comic, where Cueball says, "I will breathe when they call it", may refer to the idea that many people "hold their breath" when waiting for an important result, so people may hold their breath until the Presidential race is called. However, since this time around the announcement could have taken days if not weeks longer, literally holding one's breath until the winner was announced would not be possible.[citation needed] As it happens, the election was called for Biden the morning after this comic was published, about 3½ days after the election, although Trump was still attempting to challenge the results in court, which would make holding one's breath until all appeals and recounts are complete an even worse idea than if he had conceded. The theme of recursive naming is a recurring one in xkcd, most recently with the "contact tracer tracing program" in 2376: Curbside.

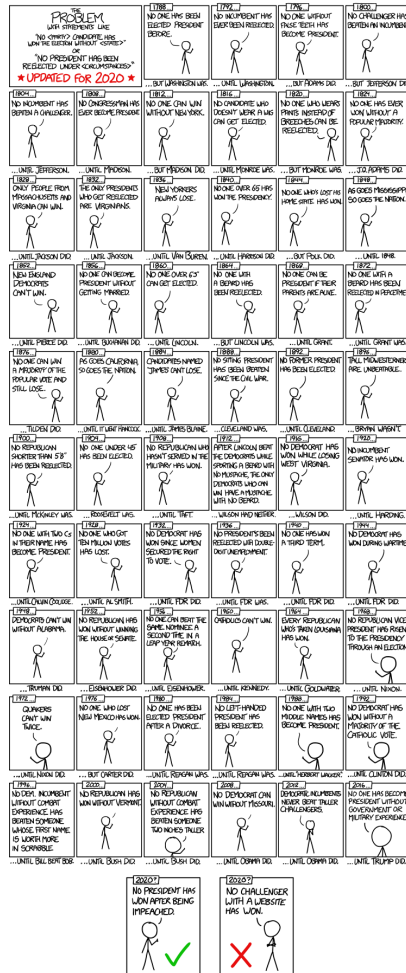
In the title text, Randall wishes good luck to the

Democrats in the state of Georgia who are running in later run-off elections. Two Senate seats were being voted on in the state of Georgia in 2020, but no candidate achieved over 50% of the vote in either race. It was highly likely that the runoffs would determine control of the Senate. By law in the state of Georgia, these two races were decided in "runoff" elections, where the top two candidates from each of the races ran against only each other, on January 5, 2021. In the end, both Democrats were elected to the Senate. Randall also wishes good luck to the SREs (Site Reliability Engineers) of Google Sheets, an online spreadsheet program, who are in charge of maintaining the Google infrastructure while people like him are constantly refreshing their sheets and pulling data. Randall is comparing Georgia's upcoming "runoff" election to the current election, calling it a "run-on" for how long it is taking.



## #2383: Electoral Precedent 2020

November 09, 2020



CONGRATULATIONS TO PRESIDENT-ELECT  
JOE BIDEN FOR BREAKING THE WEBSITE CURSE!

He also broke the streak that incumbents with websites are unbeatable and Delawareans can't win, creating a new precedent: Only someone from Delaware can defeat an incumbent with a website.

## Explanation

This comic is an update to 1122: Electoral Precedent, adding "broken precedents" for the US presidential elections in 2016 and 2020. It was published six days after the 2020 election took place, and two days after most news networks "called" the election, projecting Biden as the winner. The majority of the comic's panels are duplicates from 1122, with the exception of the 2012 panel (modified to show that Obama did in fact break the streak), the 2016 panel (added to reflect the election of Donald Trump), and the two 2020 panels. It continues the theme of pointing out that an arbitrary 'precedent' can always be invoked to predict the outcome of an election. Presidential elections happen rarely enough that each is a unique event, and something is always happening for the first time. Like with the other examples, the precedents mentioned here mix factors that could plausibly impact the election (such as one candidate having been impeached), with precedents that are just a product of time and chance (like a successful challenger having a website).

The final two panels again show how, no matter which candidate won in 2020, it would be a 'first' in some way.

- No sitting president who was impeached was even nominated for the office again until Donald Trump. (Only two other US presidents have been impeached. Bill Clinton couldn't run again afterward due to term limits, Andrew Johnson failed to be nominated at the

1868 Democratic Convention.) Until the 2024 election, it remained true that no impeached president has ever been re-elected. After Trump's 2024 election victory, it now depends on whether you count the phrase "No President" to only apply to sitting presidents.

- Prior to the 2020 election, no challenger with a website ever won. This, however, is easily explained by the fact that incumbent presidents usually win, and websites are a fairly new technology. The last time a challenger beat an incumbent was in 1992 before Internet use was widespread. By 1996 that had changed and both the incumbent Bill Clinton campaign and the challenger Bob Dole campaign had websites that look very simple by today's standards. The title text points out that one could just as easily say that incumbents with websites are unbeatable, until that precedent was broken in 2020.

The 2020 election was also precedent breaking in a few ways that Randall didn't mention:

- At 78, Joe Biden was the oldest president ever on the day of his inauguration.
- Biden's running mate Kamala Harris is the first-ever female vice president, first Black vice president, and the first Asian vice president (her parents are from Jamaica and India). She's also the first Democratic vice president from the West.
- Biden received over 80 million votes, the highest ever, beating Obama 2008's previous record of just under

69.5 million votes. The second-highest raw vote total was for Trump, with approximately 74.2 million votes, also beating Obama 2008. Turnout as a percentage of the eligible population was the highest in over a century. Unlike the other precedents, however, this one was not an inevitable outcome of a Biden-Harris victory.

Also, Biden is the first president from the state of Delaware, thus he broke the "precedent" that Delawareans can't win. Randall then proceeds to combine these 2 facts to create a new precedent: Only Delawareans can defeat incumbents with a website.

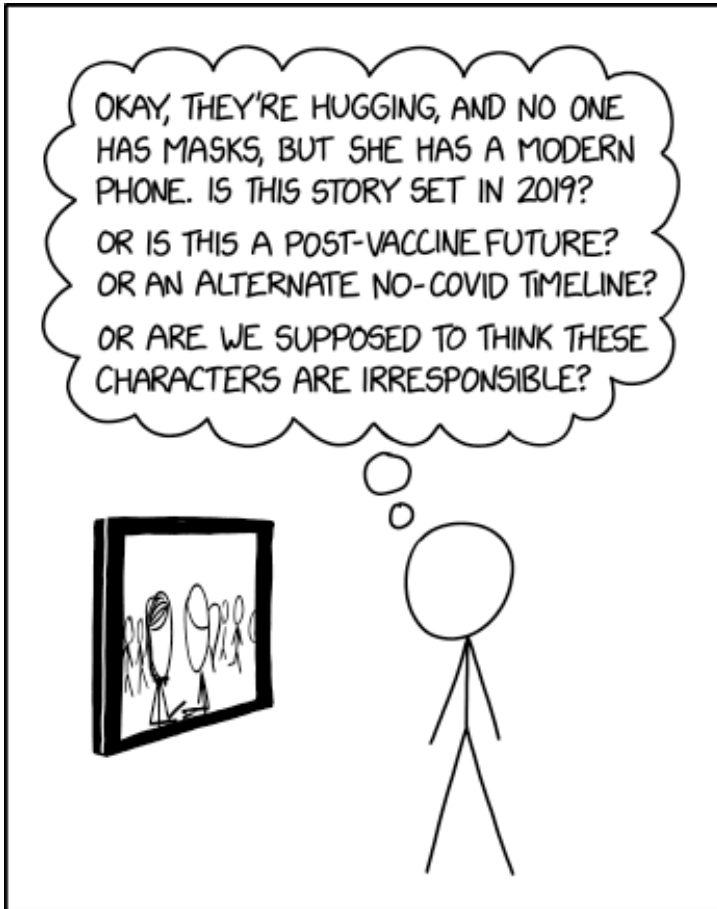
All the way up to the 2024 election, no president had ever been re-elected after being impeached. There were only ever three official impeachments, with Nixon facing "inquiries", but given that a president would have to very badly mess up (such as having an affair with a secretary or bugging high ranking officials offices) it would be thought extremely unlikely that the public would support such an individual should they seek to rerun for office, and he indeed failed to do so in 2020. However, even though Donald Trump had faced an impeachment (and now also possible jail time, for separate issues), he subsequently won with a majority of vote in 2024.

Had this exact same test been proposed again in the next election, in view of the same candidate, it would have proven untrue once President-Elect Donald Trump broke that particular impeachment 'curse'. There was no actual attempt to (re)establish this hurdle in the run-up

to the 2024 cycle, nor was it ever mentioned which barrier it might have been that his opponent did not overcome.

## #2384: Set in the Present

*November 11, 2020*



MOVIES AND SHOWS THAT ARE VAGUELY SET IN  
"THE PRESENT" WILL BE AWKWARD FOR A WHILE.

She referenced Billie Eilish, so this must be getting pretty close to the pandemic. But we've seen the last two years in-universe, so if it's set in the future, they must be in at least **2023** by now. [\*adds thumbtacks and string to wall\*]

## Explanation

This comic is another in a series of comics related to the COVID-19 pandemic.

Cueball is watching a wall-mounted television set that's showing either a movie or a TV program, and notices that none of the characters are taking the recommended precautions concerning the COVID-19 pandemic. This leads him to speculate on the timeline and internal logic of the show.

On-screen, people are talking face-to-face without face masks, and other maskless people mingle in the background. Cueball notes that, if the story takes place in the same reality and time as us, the absence of precautions should mark the characters as reckless or irresponsible (which impacts the story). Alternative explanations he comes up with are that the show might be set either prior to the pandemic or far enough in the future that the impacts are no longer visible. However, these possibilities are difficult to square with era-specific cues like technology and popular culture references.

Billie Eilish is an American singer and songwriter who first became active in 2015, and rose to stardom in 2019, so a reference to her implies a show set within the last few years, and likely only one year in the past. The presence of "modern" phones (presumably a late model smartphone) has a similar implication. But in a TV show

or film series where time passes in-universe, this also creates problems. If it's set in the recent past, and the series continues for a few more years, then the characters should encounter the pandemic in later seasons. If it's set in the future, then the entire series must be set in the future (because none of it included the pandemic). If the series has gone on for several years, the current episode must be at least several years in the future, which raises the question of why all the technology and pop culture shown is familiar to us.

The simplest explanation is that COVID-19 doesn't exist within the program's universe (an idea Cueball briefly considers as an "alternate timeline," but doesn't dwell on). Perfect consistency with the real world in fiction is hard to achieve, and how accurately stories track to current events varies widely. Movies and television productions are enormously complex, and months, if not years, can pass between when a screenplay is written and the finished product is released. This means that rapid changes in the real world are rarely reflected promptly in fiction. Alternately, the production might have taken place in the COVID era but the creators consciously chose not to include the pandemic in the story. Some viewers can ignore these inconsistencies, but for others, they make suspension of disbelief impossible.

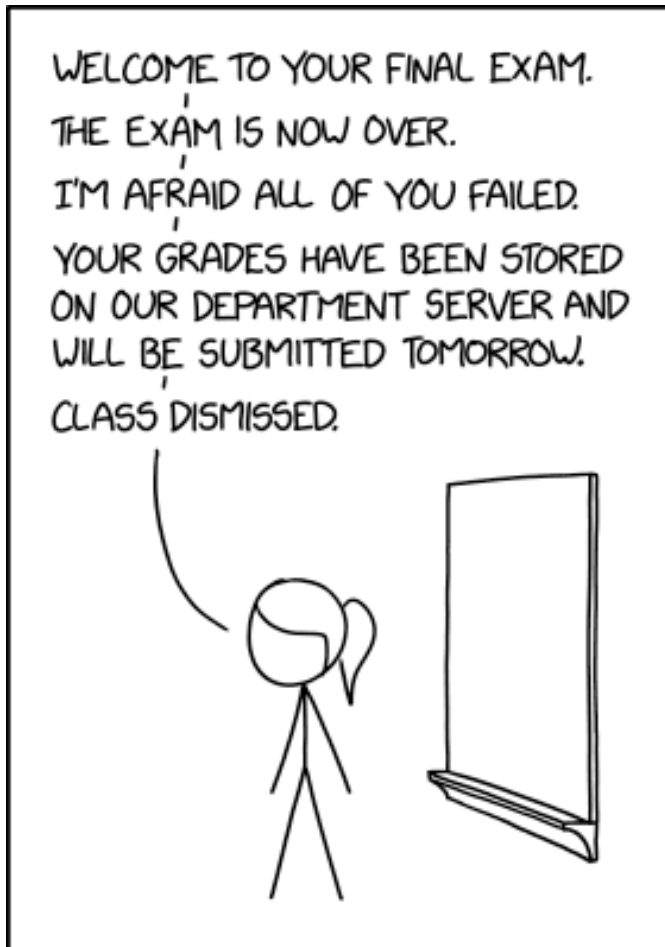
Cueball has previously been distracted by minor details in film or television in 1451: Background Screens. The idea of using thumbtacks and strings (usually accompanied by newspaper clippings and photographs) to study a problem is pop-culture shorthand for a



conspiracy theory. Randall has previously mentioned this in 2244: Thumbtacks And String.

## #2385: Final Exam

*November 13, 2020*



### CYBERSECURITY FINAL EXAMS

For those of you also taking Game Theory, your grade in that class will be based on how close your grade on this exam is to 80% of the average.

## Explanation

In this comic, Ponytail appears to be administering a group sitting for cybersecurity exam. However, at the beginning of the exam, she informs her students that they have all failed, despite not having taken a test yet. She then informs them that their grades are stored on the department server and will be submitted the next day. The implication here is that the true test, rather than being a traditional exam, is actually whether the students can hack into the server and change their grades. This may be a jab at education security which is known to be vulnerable to assault (not the first time xkcd has made such a joke). In real life, students have attempted to change their grades in this manner, with occasional success.

The title text adds a twist to this. In order for a student to get a good grade in the game theory class, they need to get a below-average grade on this final exam. This incentivizes the students to also change the grades of other students when they change their grade. However, this is more complicated than it seems, and depends on various factors, such as the fraction of students who take game theory in addition to cybersecurity. If, for example, half of the students also take game theory, then for all of them to get 80% of the average score, even assuming that all their non-game-theory classmates get maximum possible score, they would have to target for  $\frac{2}{3}$  (or about 67%) of the maximum possible score, to get 80% of the final average. While that would make their game

theory grade perfect, it might noticeably worsen their cybersecurity grade. This gets progressively worse with the increasing fraction of students who take game theory along with cybersecurity.

In the extreme case of all cybersecurity students also taking game theory class, this degenerates into another common game theory problem: Guess  $\frac{2}{3}$  of the average of everybody's guesses. The only group-wide winning strategy is, of course, for everyone to guess 0, which means that  $\frac{2}{3}$  of the average will be 0. This assumes perfect rationality of all players with respect to the game theory problem. The catch is that here we have the same number as a grade for the cybersecurity exam and for the game theory guess. We'd like one to be as high as possible, and the other to be zero or close to zero, which are obviously conflicting goals.

To improve their overall results, students could resort to various compromises and strategies, such as increasing other students' scores against their will, or making alliances with students who might not mind taking a hit to their game theory grade (perhaps in exchange for other incentives) - these are all topics that the game theory class would have been dealing with. Specifically, this test seems to refer to the prisoner's dilemma and tragedy of the commons; if one student changes their grade to 80% of the average, they will receive high marks, but if more and more students attempt this, the gain for each one drops and tends towards zero.

The combination with cybersecurity adds another layer

of complexity, in that students could, for example, also attempt to lock each other out of the server to achieve maximum control over the results to their benefit.

In the strip, there is no actual test to take. But if there was one, there would still be strategies to optimize performance without hacking the grades. One option would be to take the test normally, and then change every fifth answer to the bubble below it; using this strategy your overall grade will drop to 80% if you were at 100%, and may even raise your score if a student performed particularly poorly. The trick, though, is that other students (assuming rationality) would try this strategy as well; thus, a student may need to overcorrect more, weigh the possibilities of whether any of their classmates had followed this as well, and perform this recursively until it is most likely that the score is 80 percent of the average.

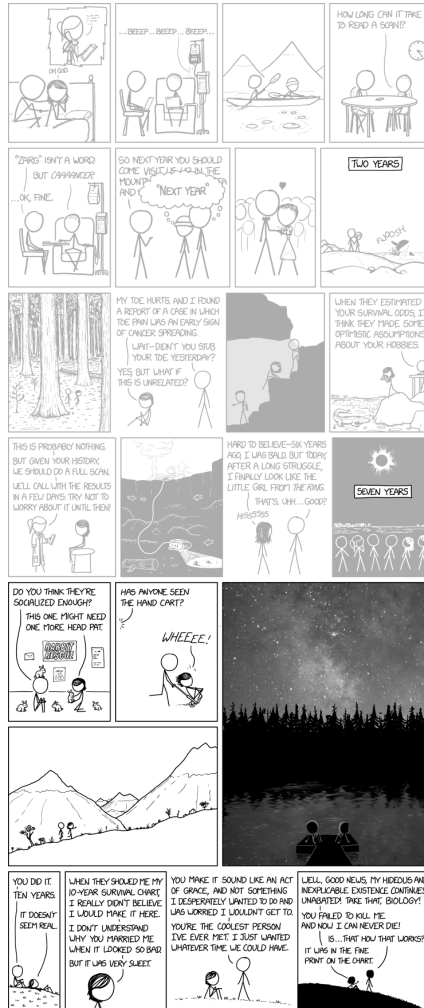
Note: All of the above is based on the assumption that the game theory mark will be directly (and not inversely) proportional to how close the cybersecurity grade is to 80% of the average. This is left ambiguous in the formulation.

Note: The above also assumes the system accepts a maximum of 100%. If (as is likely) the system allows for extra credit you could reach a Nash equilibrium by setting the non-game theory students to an arbitrary, but very high, number (say 2000%)  $C$  and then the game theory students to  $(C * g) / (.25 + g)$  where  $g$  is the percentage of students not in game theory.

Note: The solution becomes trivial if the game-theory grade is stored on the same server but submitted after the cybersecurity grade. Students would simply give themselves full marks on cybersecurity, then edit the game-theory grade after cybersecurity has been submitted.

# #2386: Ten Years

November 16, 2020



The ten-year cancer-versary is traditionally the Cursed Artifact Granting Immortality anniversary.

## Explanation

Randall's then-fiancée, now wife was diagnosed with cancer in late 2010. This is a matter he has discussed in the comic multiple times before, with Randall being depicted as Cueball and his wife as Megan. At this comic's release, it had been 10 years since her diagnosis and treatments.

This comic is a continuation of 1141: Two Years and 1928: Seven Years, which are shown in the first 16 panels, slightly grayed out.

The first of the new panels shows Randall and his wife at a "Rabbit Rescue", interacting with buns (a recurring theme of xkcd). The purpose of such events is to get rescued (often surrendered or seized) rabbits or other animals used to interacting with each other and with unfamiliar humans under controlled circumstances, to help them be more suitable as pets and hopefully entice visitors to adopt them. Randall facetiously asks his wife if she thinks the rabbits have socialized enough, even though he and his wife are there for the sake of their own enjoyment (and she indicates that she would like to spend more time patting a bunny on its head).

In the next panel, Randall is pushing his wife in a handcart, which is presumably stolen. (As evidenced by the off-panel person asking if anybody has seen the handcart.)



The third new panel shows Randall and his wife exploring a mountain. They appear to have found something interesting, due to Megan pointing her finger towards something off-panel. It appears to be a reference to a similar climbing scene from 1190: Time.

The fourth panel shows Randall and his wife sitting on the edge of a pier, looking at the night sky. This is a typical romantic nighttime activity. The panel is distinguished because there was considerably more effort put into the drawing of this panel than of the other panels, by virtue of it being nighttime. Thus, the reflection of the starlight on their faces is the center of attention in the drawing.

The final new panels show Randall and his wife sitting on a hill, talking about how they couldn't believe that she would make it to 10 years cancer-free, which according to 881: Probability wasn't all that certain (77% probability -- the probability of picking an M&M out of a bag at random and getting one that isn't blue). Randall's wife voices a concern that she had seemingly been carrying for a while, that she was a burden to Randall, and explains that she couldn't understand why he would marry her, except as a show of grace. Randall firmly rejects this notion, stating that it was no mere gesture, but that it was important to him that they enjoy "whatever time we could have".

Finally, and as with the first comic in the series, the comic takes a light-hearted turn: because the table does not include values for probability of survival more than

ten years after treatment, Randall's wife jokingly concludes that she is now immortal, perhaps thanks to a cursed artifact. Many anniversaries are traditionally marked by giving gifts, such as the silver jubilee after twenty-five years of marriage (or of a monarch's reign, or an employee's seniority within a company, or anything else). The tenth anniversary is traditionally associated with a tin gift (tin being a much more precious metal in 1922 than it is today), but maybe Randall bought it at a cursed shop.

The title-text expands on this final joke, as it suggests that there is an official name for this giving of cursed artifacts once the ten-year mark has passed. Also, it seems as though Randall has finally found a less-gross name for this anniversary than "biopsy-versary".

Cursed artifacts that cannot die were also mentioned in 2332: Cursed Chair.

## #2387: Blair Witch

November 18, 2020



"Are you concerned the witches won't breed in captivity?"  
"Honestly, we're more concerned that they **WILL**. We don't know what it involves, but our biologists theorize that it's 'harrowing.'"

## Explanation

The Blair Witch Project is a found footage horror film released in 1999. For the marketing campaign of the film, the producers created the legend of the Blair Witch, a supernatural being whose legend originates in Burkittsville, MD. As it sometimes happened in Protestant societies in the colonial era, a woman was ostracized from the community after having been accused of witchcraft. This woman, who tends to conflict in name with various versions of the lore, would supposedly attempt to inflict revenge upon the community that exiled her, and these fearful people fled from the town.

The comic takes a humorous turn on the legend, suggesting a conservation program to save the Blair Witch. While the film was described by reliable sources as faked and misrepresented footage, the Blair Witch is postulated as separate species that is being tracked by the IUCN Red List. With the rise of camera-phones in the modern age, sightings of beings that are most likely fictitious, such as Bigfoot and the Loch Ness Monster, are becoming rarer over time, due to lack of credibility of a reported sighting without visual evidence (although with the rise of deepfakes, even visual evidence might lose credibility in the future). A species which has not been notably documented for a long time would indeed be moved to the "possibly extinct in the wild" category, as Megan notes.

Rather than taking this to mean the Blair Witch does not exist however, Megan instead suggests habitat loss as the reason why encountering a Blair Witch might be more difficult. Habitat loss is in fact one of the most prominent and concerning reasons for extinction in recent years. Megan claims that suburban projects have fragmented the witch's "spooky forest" ecosystem, a reference to the many species that are dying off due to encroachment, logging, and similar human activities. Migration due to climate change is also an observable phenomenon in animal populations (and some plant populations, depending on their mode of travel while in seeds; those that rely on animals to germinate will migrate as well).

Megan then proposes a plan to catch and breed Blair Witches in an attempt to resurrect the species. This final panel is more obviously humorous, as even if the Blair Witch did exist separate from humans, there is only one,[citation needed] and thus any attempt to breed and repopulate would be futile. It may be possible that this is not a problem, but if it is, it could also raise the objection that any pair of Blair Witch may both be female, and thus unable to reproduce. This could be resolved by (a) assuming that Witches can (sometimes?) be male as well, (b) assuming that half of Blair Witches are transgender, or (c) assuming that, much like Tremblay's salamander, females can reproduce with a male of a related species (most likely human, in which case the project might have difficulty obtaining approval from an ethics review board.) The phrase "Blair Witch Reintroduction Project"

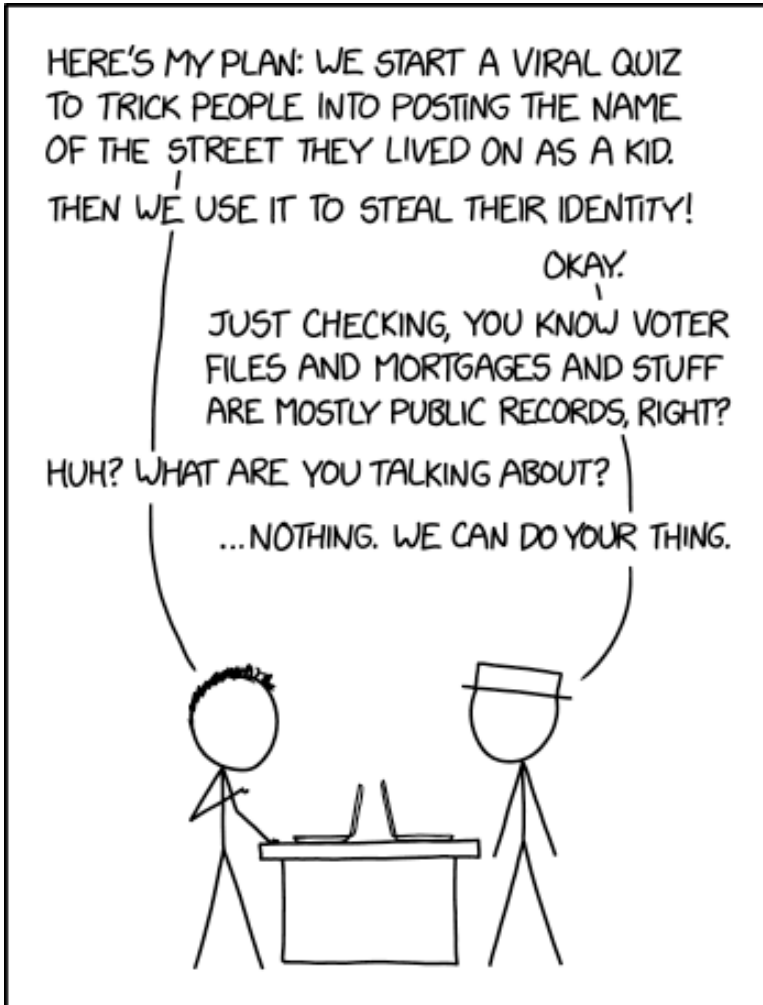
is a reference to The Blair Witch Project.

The title-text suggests that the comic is a lecture, as Megan's whiteboard and pointer would suggest. A (presumed) student asks whether Megan is concerned that witches won't breed in captivity (a serious real-world concern to the IUCN). If this is a press conference, the question would be asked by a reporter instead. Megan replies that they are worried that there will be breeding, but biologists are unsure how the breeding occurs, calling it "harrowing" (presumably because they have captured the Blair Witch and it has set a curse on their laboratory as she supposedly did in Burkittsville). Historically, communities practicing witchcraft may have fled to the woods to engage in sometimes very sexual behaviors that others at the time were very frightened by.

Randall previously wrote about an ill-advised fauna introduction project in 2349: Rabbit Introduction, but at least rabbits are cuter and less harrowing than witches.[citation needed]

## #2388: Viral Quiz Identity Theft

November 20, 2020



[scrolling through a giant spreadsheet of transcribed data] 'Wow, a surprising number of users grew up at 420 69th St.' 'Yeah, must be a high-rise or something.'

## Explanation

Hairy is trying to compile a list of names and addresses, for identity theft purposes. He intends to do so by posting an online quiz to entice people into posting their personal information; for example, asking people to post their 'porn star name' by combining their pet's name (or their middle name, or their mother's maiden name) and the street they grew up on. However, as White Hat points out, a lot of this information is already in the public record making his "viral quiz" unnecessary. This comic is one of very few where White Hat's argument is not used as a straw man; rather, Hairy is the unenlightened one and White Hat has the idea that will require much less work for the same result. However, when Hairy proves to have no idea about public records, White Hat decides that it will be easier (or at least more fun) to just play along with Hairy's plan rather than try to educate him.

Even though White Hat is correct that there are public databases with lists of legal names and addresses, lots of online interactions take place in forums where people adopt pseudonyms. A viral quiz like this one could be useful for de-anonymizing users, a process known colloquially as "doxing". There is also a suspicion that these kind of viral quizzes are used to create databases to answer password recovery questions correctly. Together with a man-in-the-middle attack on the email system used, this can lead to hackers taking over user accounts.

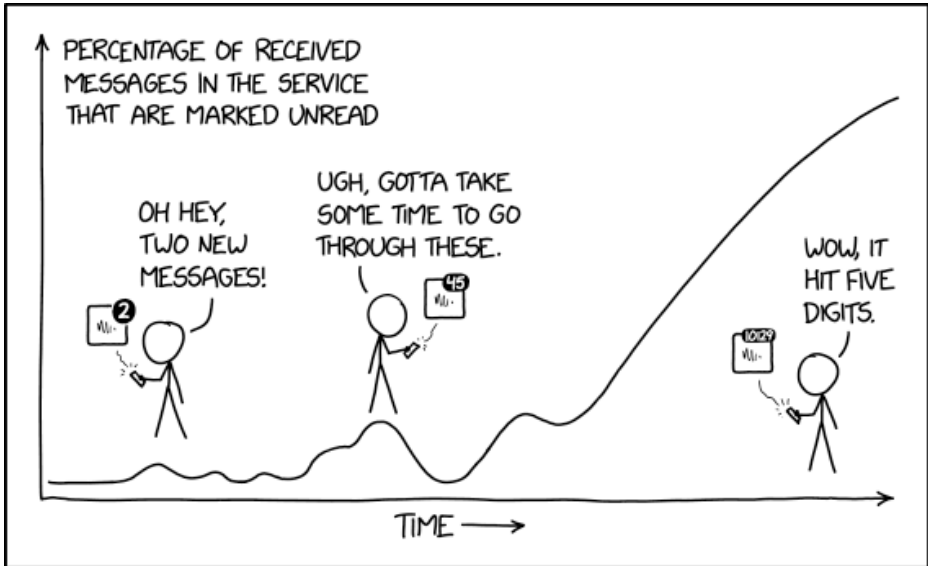


In the title text, it turns out that lots of users did not provide their personal information. Instead they provided fake information, which Hairy naively takes as truth. The number '420' is associated with the use of marijuana and the number '69' is used to refer to a sex position. These two numbers have found their way into society from memes to car prices. White Hat could also be taking the data at its word when he replies that there must be a high-rise building at that address to hold so many respondents, but it is more likely that he is making a sarcastic double-entendre pun. 420 69th St. is a real address in several US cities, but it looks like they're all single-family dwellings or small offices, not high-rises.

If Hairy had talked to Black Hat, he might have been told about the time Black Hat made a bunch of free web services to harvest usernames and passwords. Black Hat's project stalled when he realized that he didn't know what he wanted to do with the information he harvested, and Hairy's plan doesn't seem very well-thought-out past the "get personal details" step either.

## #2389: Unread

November 23, 2020



ANOTHER WAY EVERY SYSTEM EVENTUALLY BECOMES EMAIL

I'll never install a smart home smoke detector. It's not that I don't trust the software--it's that all software eventually becomes email, and I know how I am with email.

## Explanation

Cueball has an unspecified communication application on his phone. As the chart displays, the longer he has the app, the more unread messages he has on it (likely due to a combination of more people trying to contact him over it and him checking it less diligently). Eventually, he gives up reading every message, and he notices apathetically when it reaches 10,000 notifications. The joke comes in the caption, which states that all communication services have this problem and implies that this problem is the key problem with email.

The caption, "Another way every system eventually becomes email" (emphasis added) is a reference to Zawinski's law of software envelopment: "Every program attempts to expand until it can read mail. Those programs which cannot so expand are replaced by ones which can." In this case, it's not that every program will eventually become capable of sending and receiving emails, but rather that Cueball/Randall will treat every program that provides notifications the same way he treats his email inbox.

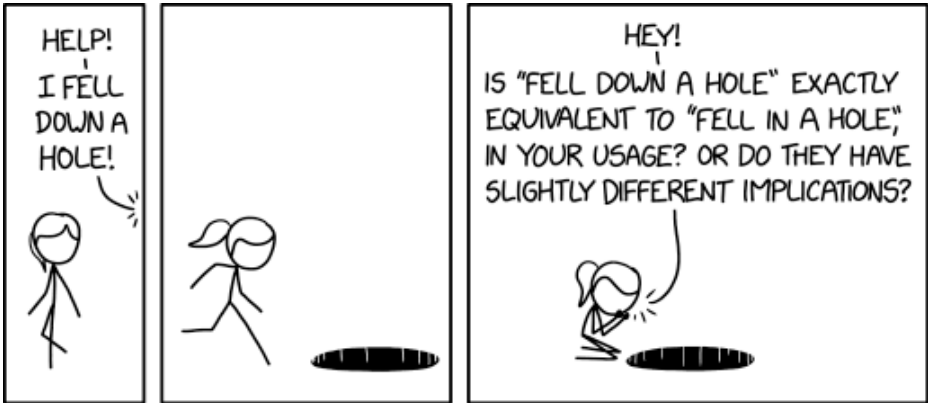
In the title text, Randall uses this reasoning to explain why he'll never install a smart smoke detector. A smart detector would send a notification to his phone when the smoke level is high enough to trigger it, or perhaps when it is running low on battery; following the same trend, Randall believes he will eventually stop reading the alerts from the smoke detector. Ignoring a smoke detector is

dangerous.[citation needed] Traditional (non-smart) smoke detectors typically use sound to denote status, with very loud piercing sounds used to indicate events requiring immediate notice (i.e. an active fire producing large amounts of smoke) and quieter chirps to indicate other conditions, such as low battery levels. While some people can and do tune out the low battery warnings, it tends to be difficult to ignore the active fire types of alerts. However, a person would need to be within hearing range for those alerts, versus allowing people to ignore alerts from around the world with a smart smoke detector.

Randall has previously covered his trouble keeping up with email, for example in 1783: Emails.

## #2390: Linguists

November 25, 2020



THERE'S A MYTH THAT LINGUISTS ARE PEDANTS WHO LOVE CORRECTING PEOPLE, BUT THEY'RE ACTUALLY JUST ENTHUSIASTIC ABOUT UNDERSTANDING LANGUAGE IN ALL ITS INFINITE VARIETIES, WHICH IS MUCH WORSE.

"Do you feel like the answer depends on whether you're currently in the hole, versus when you refer to the events later after you get out? Assuming you get out."

## Explanation

Ponytail hears the cries of an unidentified person who has become trapped in a hole. She rushes over, but rather than helping the person out, she instead asks whether the trapped person's chosen phrasing for their predicament – "fell down a hole" – is equivalent to "fell in a hole."

To most people, the phrases "fell down a hole" and "fell in a hole" are paraphrases. To other people, however, the two sentences have a subtle difference that implies slightly different things; for example, whether one has fully or only partially fallen down/in the hole, how big the hole is, or whether the person has exited out of the hole yet at the time of speaking (see the paragraph on the title text below). Ponytail is thus asking whether the person chose to use 'down' over 'in' for those reasons. In either case, the joke here is that this is probably not the best time for Ponytail to ask.

In the caption, Randall comments on the stereotype that linguists are obnoxious pedants who obsess over correct grammar usage ("Grammar Nazis"). Tongue in cheek, he remarks that the truth is actually much "worse", because at least pedants will have the social awareness that if somebody fell down a hole then it is likely not the correct time to engage in any so-called pedantry - a situation shared by the characters in 1010: Etymology-Man.

This is similar to the viewpoint dedicated to scientists in comic 877: Beauty, as in studying that field seems to be a

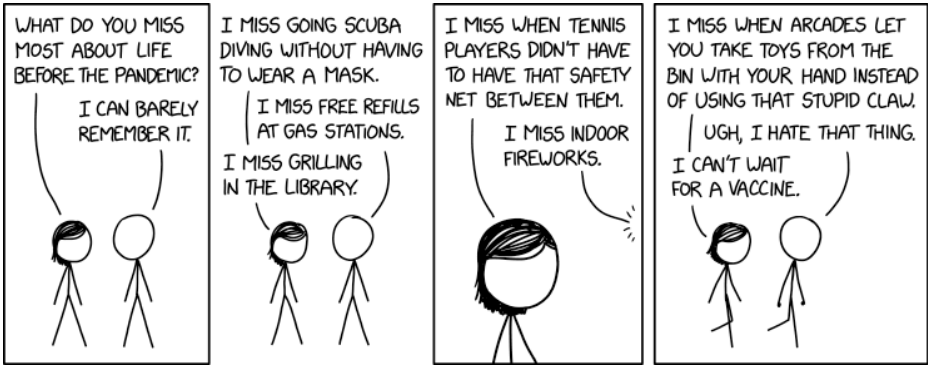
cold and sad way to analyze the thing, but instead is an extreme form of child-like awe and inspiration.

The title text sees Ponytail asking the person whether their answer is dependent on the current situation, or in technical terms, tense-aspect-mood. As noted above some people see the difference between 'fell down' and 'fell in' as to whether the sentence still holds true at the time of speaking; this is called the perfective aspect. There are other variations, such as recent vs. remote past: "I just fell down a hole"; the perfect (not to be confused with the first one - note the lack of -ive): "I fell down a hole, and it has consequences relevant to our conversation"; habitual: "I had previously fallen down a(nother?) hole, and I have fallen down this hole now", all of which can influence one to choose 'down' over 'in' or vice versa.

The last sentence "assuming you get out" drives home the point that Ponytail is concerning herself with linguistic matters over practical ones. Ponytail's use of "assuming" rather than "when" suggests that Ponytail doesn't have a plan to get the person out, or that she has a plan but isn't confident in its success. The former interpretation, that Ponytail is thinking of the person getting out as abstract and unconnected with her, is funnier and more consistent with Ponytail's actions so far.

## #2391: Life Before the Pandemic

*November 27, 2020*



I can't wait until this is all over and I can go back to riding my horse through the mall.



## Explanation

This comic is another in a series of comics related to the COVID-19 pandemic.

Megan and Cueball are having a conversation about life before the pandemic, which was declared as such on the 11th of March, 2020 by the World Health Organization. They talk about what they miss about life before the pandemic, but Cueball says that he can barely remember it. This is borne out by the rest of their discussion: None of the activities they list were ever common and most are strange, some are even forbidden and various items are misconstrued as existing for pandemic mitigation purposes.

After they finish reminiscing, Megan says that she can't wait for a vaccine, further implying that she can't wait to have all of these things "back." Both Pfizer/BioNTech and Moderna are making vaccines, with Pfizer/BioNTech making their application for emergency use on November 20th, 2020, 7 days before this comic's release. It is expected to be approved for use by the end of the year.

### **Scuba diving without a mask[edit]**

Scuba stands for Self-Contained Underwater Breathing Apparatus. It consists of a tank of compressed air, which is conducted through a tube to a mouthpiece which allows the diver to breathe underwater. A mask is a fundamental part of scuba diving to allow the diver to see underwater better. Cloth masks, to

help lower the spread of the virus between people, are a recommended precaution when in public, but wearers are advised not to wear them when swimming. Megan is conflating these two different types of masks, misremembering a world where scuba diving did not have masks involved. You do not need to wear a cloth mask if you are scuba diving, but you do need to wear a scuba mask—regardless of whether there is a pandemic.

Scuba masks previously rated quite well on the mask effectiveness scale in 2367: Masks. However because the regulator is technically not a face covering, Megan's Scuba club may be requiring full face or "hardhat" style diving equipment, which would justify her complaint.

### **Free refills at gas stations[edit]**

Gas stations are locations where you can buy gasoline, which powers internal combustion engines, especially those in cars. Many of these locations have a small convenience store attached, where customers can purchase snacks or drinks while having their car filled up. It's unknown whether Randall/Ponytail meant "free refill" of gasoline or of drinks from the convenience store, but either way it was not a business practice that was common.[citation needed] Free refills of drinks are more associated with restaurants and diners, who allow free top-ups of relatively cheaper soft drinks, tea, or coffee, in the hopes that it will attract people to come in and buy more expensive meals to cover the cost.

### **Grilling in the library[edit]**

Grilling food generally poses a significant fire hazard (and can produce toxic carbon monoxide) and is thus typically not allowed

indoors, especially in libraries, whose shelves full of flammable paper books present both an increased fire hazard (as the fire could spread more quickly with plenty of fuel, and the shelves could potentially hamper efforts to evacuate the library if the fire made that necessary) and a liability (because if the books burned, they would be destroyed/unusable, and it would likely cost a lot of money to replace them). In the pandemic, many libraries discourage people from spending time there, preferring that visitors only check out or drop off books. Some libraries have even removed chairs to achieve this.

Even if grilling were allowed in Cueball's and Megan's library beforehand, it would not be allowed during the pandemic, as it would involve eating in an enclosed area, an activity specifically warned to increase the contagiousness of the virus. Backyard (or library) cookouts have been discouraged by the Center for Disease Control and Prevention, or CDC, because of this.

### **Tennis without a "safety" net[edit]**

Tennis is a sport where two players use racquets to hit a ball at each other. The game is played on a court divided in half by a low net. The net is not used for anyone's safety; it's to ensure that the ball must be volleyed to the other player with some minimum height. Megan seems to believe that the net is there to ensure that the players stay on opposite sides of the net, in order to lower the spread of the virus.

### **Indoor fireworks[edit]**

Many indoor activities were moved outdoors during the COVID-19 pandemic, as poorly-ventilated indoor spaces vastly increase the chance of the virus spreading. Fireworks are

explosives shot into the air for entertainment. Due to inherently being explosive, fireworks can be dangerous, i.e. cause injuries or even death. Some countries (for instance, The Netherlands) have temporarily banned fireworks because of COVID-19, reasoning the fireworks-induced injuries would put additional stress on hospitals that are already nearing maximum (intensive care) capacity due to COVID cases. Most fireworks are not suitable for use indoors; setting them off indoors is even more dangerous than they already are, even before the pandemic.[citation needed] However, there are specially designed indoor fireworks, most often used by specially trained and licensed pyrotechnicians. These are usually seen in large indoor venues for concerts and sporting events, both of which have been curtailed due to the pandemic. In this case Cueball would be accurately lamenting his inability to enjoy indoor fireworks.

## **Arcade claw machines[edit]**

Arcade claw machines have a bin of prizes (often stuffed animals) with a claw mechanism hanging overhead. The player pays a few coins into the machine and maneuvers the claw over a desired prize. The claw will descend and "attempt" to grab the prize for retrieval. There is often a hidden percentage chance that the claw will not fully close.

This is a frustrating experience for the player (e.g. Cueball), but he misunderstands the purpose of the claws. While manipulator arms are also used for handling dangerous items, the claws in these machines are not to reduce coronavirus spread. Instead, they make toy-grabbing deliberately inefficient so that people may play again and pay more money. If people could take toys freely from the bin with their hands, operators would lose money, as people could

take multiple toys or avoid paying entirely. It is unlikely that they would allow this even after the pandemic.

Out of frustration, some players attempt to reach through the deposit hole in order to try to take one of the stuffed animals or other prizes without the use of the claw. Since multiple people would presumably have already touched the metal interior, this is an effective way to spread the contagion quickly, which makes it even more imperative to discontinue this practice. There are other dangers to doing this as well; one can get their arm stuck in the machine, and can even cause themselves serious damage.

Again it is possible that the arcade used a ticket or token system where one could cash out their winnings for self-selected items such as plush toys. As a COVID mitigation, the arcade may have found it necessary to make the plush toys only available via an enclosed claw style "skill" game.

### **Title text: Riding a horse through the mall[edit]**

A mall, in a historical context, refers to a large open walkway, such as the National Mall, where one could conceivably enter with a horse, although it was considered inappropriate to do so. However, it appears Cueball and Megan are referring to a shopping mall, where a shopper entering with a horse was never a regular occurrence[citation needed], at least in universes where there isn't a horse in aisle five.

## #2392: Cyber Cafe

*November 30, 2020*

WHICH WORD IN THE  
NAME "CYBER CAFE"  
SOUNDS MORE DATED?

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2015 - CYBER

2016 - CYBER

2017 - CYBER

2018 - CYBER

2019 - CYBER

2020 - CAFE

Since we haven't really settled on a name for those online hangout/work spaces that try to recreate the experience of cafes, and I love confusion, I'm going to start calling them 'cyber cafes' or 'internet cafes.'

## Explanation

This comic is another in a series of comics related to the COVID-19 pandemic.

A cybercafe, or Internet cafe, is a cafe or other restaurant that provides Internet access. Prior to widespread ownership of personal computers and cell phones, such cafes would host computers that clients could use, and nowadays, many fast-food restaurants and cafes provide free Wi-Fi to their customers, so that people can use their computers while at the cafe. "Cyber" is a prefix meaning something relating to computers (as in Cyber Monday, the day the comic was posted), but this comic suggests that it sounds dated, previously discussed in 1573: Cyberintelligence. However, in 2020, he jokes that "cafe" actually sounds more dated. This is a result of lockdowns related to the COVID-19 pandemic preventing people from going to cafes, and like the preceding comic is a play on the sense that the lockdowns could shift economies and cultures to remove parts of the physical world permanently, depending on how long they last.

In the title text, Randall indulges his munchies of ambiguity by proposing that the term "cyber cafe" be re-used to refer to online hangout spaces that try to feel like cafes. This would change the meaning from "a cafe where computers are available for use by patrons" to "a setting or activity in cyberspace that feels like a cafe" (which would at least be inline with similar terms, like cyberbullying, cybersex, etc.).

## #2393: Presidential Middle Names

*December 02, 2020*

# PRETTIEST PRESIDENTIAL MIDDLE NAMES OFFICIAL RANKINGS (UPDATED FOR 2021)

1. GAMALIEL (WARREN HARDING)
2. ROBINETTE (JOE BIDEN) (NEW!)
3. DELANO (FRANKLIN ROOSEVELT)

The bottom of the list remains unchanged. Poor  
Rutherford Birchard Hayes.



## Explanation

A list of what Randall perceives will be the prettiest presidential middle names after the inauguration on January 20, 2021. Joe Robinette Biden (46th president-elect) will take the second slot bumping previous second-place holder Franklin Delano Roosevelt, the 32nd president, back to third. Warren Gamaliel Harding, the 29th president, remains in first. Robinette is Biden's grandmother's maiden name.

Overall, the ranking would not include every president, as many early presidents, such as George Washington and John Adams, lacked middle names. Some presidents were also more commonly known by their middle names as opposed to their first names, particularly John Calvin Coolidge, Stephen Grover Cleveland, Hiram Ulysses Grant, and Thomas Woodrow Wilson. In the case of Grant, the Senator who enrolled him at West Point messed up his full name as Ulysses Simpson Grant, hence he is widely known as Ulysses S. Grant with the spurious middle "S". Also, Harry S Truman's middle name was just the letter S and was not an initial of a name; Truman's parents could not agree on which of his grandfathers' names to give him, but luckily they both started with the letter. One president has even changed his entire name: Gerald Ford was born Leslie Lynch King, Jr., officially changing his name in 1935. The humor is based on the sheer oddity of ranking people by the perceived prettiness of their obscure middle names. There is no evidence in the comic for how Randall's list

would deal with these cases.

The title text announces that Rutherford Birchard Hayes, the 19th president, remains at or near the bottom.

### **List of Presidents with middle names[edit]**

(updated for 2021, as the comic)

The Presidents without middle names — almost all of those before Grant, and a few a bit later — were George Washington, John Adams, Thomas Jefferson, James Madison, James Monroe, Andrew Jackson, Martin Van Buren, John Tyler, Zachary Taylor, Millard Fillmore, James Buchanan, Abraham Lincoln, Andrew Johnson, Benjamin Harrison, William McKinley, and Theodore Roosevelt.

## #2394: Contiguous 41 States

December 04, 2020



TIRED OF BEING LEFT OFF MAPS OF THE US, ALASKA AND HAWAII  
BEGIN PRODUCING MAPS WITH *OTHER* STATES MISSING, TOO.

Linguists, settling some inscrutable grudge, have been steadily sneaking more backdated synonyms for 'sharing borders' into the dictionary. They've added 'contiguous,' 'coterminous,' 'conterminous,' and next year they're adding 'conterguous.'

## Explanation

The United States of America is composed of 50 states, 48 of which are contiguous – meaning they share common borders. Two states are separated from the other 48 states, Alaska and Hawaii. Alaska, purchased from Russia in 1867, is separated from the rest of the United States by the country of Canada (or at least appears to be as a result of the Mercator Projection). Hawaii, annexed in 1898, is a group of islands in the Pacific Ocean. As these states are not contiguous to the rest of the 48 states, they may be omitted from maps of the United States. Typically, these 2 states are included in inset maps, separate sections usually placed at the bottom of the main map.

The United States also includes 5 permanently inhabited territories (Puerto Rico, U.S. Virgin Islands, Guam, Northern Mariana Islands, American Samoa), which are not contiguous with states. Puerto Rico may become a state. The District of Columbia is not (yet) a state, but is contiguous with the states.

The map in this comic is "Alaska and Hawaii's revenge", with seven additional states removed: North Dakota, South Dakota, Nebraska, Kansas, New Mexico, Pennsylvania, and Delaware. Most of these are accomplished by eliminating a column of states: North Dakota, South Dakota, Nebraska, and Kansas. Oklahoma and Texas, which are directly south of these, are slid over to the west into the space freed up by

deleting New Mexico. The other two deleted states are Pennsylvania and Delaware, with the states to their south and north slid/extended to fill the gap.

The map is also missing Isle Royale, Michigan, the third-largest island in the contiguous U.S. This seems to be a legitimate oversight, as the map includes numerous smaller islands in detail, including Michigan's Beaver Island and North Manitou Island. Even the non-contiguous Northwest Angle of Minnesota is depicted. (The Eastern Shore of Virginia, which is not connected to the rest of Virginia and only borders Maryland, is also not shown—presumably to make way for New Jersey replacing much of the Delmarva Peninsula).

Some states, while not removed, are significantly distorted. Iowa and Missouri lose their contours with the Missouri River, while Wyoming's eastern border is crooked. The eastern border of Maryland follows the Delaware river with New Jersey. The border between Oklahoma and Arkansas is moved west. Western New York is wider in the comic than it is in reality. Also, the location of the Niagara River, separating Lake Erie and Lake Ontario, is much less distinct than in reality.

The United States did have exactly 41 states for a few days in 1889, from the admission of Montana, the 41st state, on November 8, to the admission of Washington (the state, not DC), the 42nd state, on November 11. However, it was not the same 41 as shown here; for example, Pennsylvania and Delaware were two of the

original 13 states (Delaware calls itself the first state, based on date of ratification of the Constitution) and Arizona and Oklahoma did not become states until the early 1900s.

The title text riffs on synonyms for "shared borders", which, according to Randall, linguists are inventing more of (while claiming they already existed) to make life more complicated for modern English users, for obscure reasons.

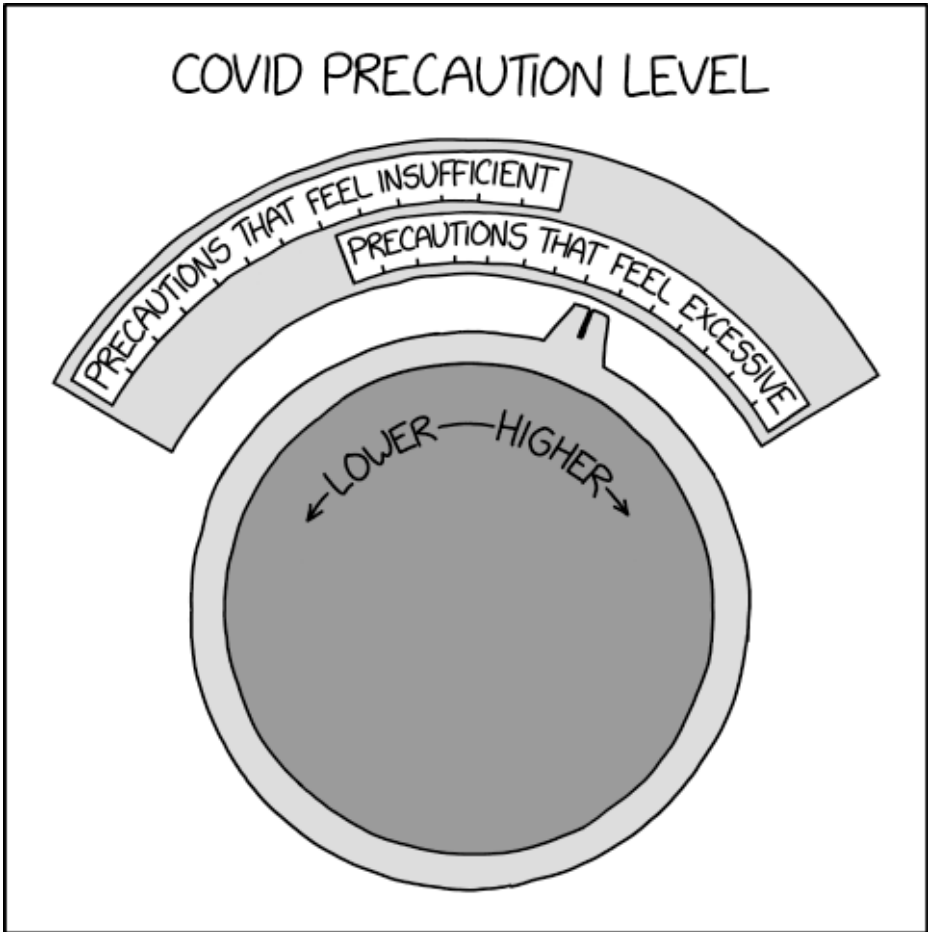
In fact, 'contiguous', 'coterminous', and 'conterminous' all date from early modern English, early-to-mid 17th century (just after the time of Shakespeare). 'Coterminous' and 'conterminous' are alternate spellings from the same Latin root ('cum' + 'terminus'), whereas 'contiguous' is from a different root (Latin 'contiguus'). Randall, facetiously, accuses linguists of having fabricated this history.

'Conterguous' is a neologism by Randall, though he blames it on linguists, consistent with his claim that they made up all the others. It is a portmanteau of 'CONTERminous' and 'contiGUOUS'. It is etymologically absurd (the prefix 'conter-' is meaningless). Its 'top-down' introduction into the language would simply be for the purpose of messing with people's minds, as Randall suggests. However, should the word catch on with English speakers, perhaps precisely because it is a joke, its 'bottom-up' entry into the language is certainly possible. One could then argue just how much Randall would have to answer for.

Three years later Randall made the opposite type of map, where he added 14 states and asks people to label all 64 (of 50) states in 2868: Label the States.

## #2395: Covid Precaution Level

*December 07, 2020*



It's frustrating to calibrate your precautions when there's only one kind of really definitive feedback you can get, you can only get it once, and when you do it's too late.



## Explanation

This comic is another in a series of comics related to the COVID-19 pandemic.

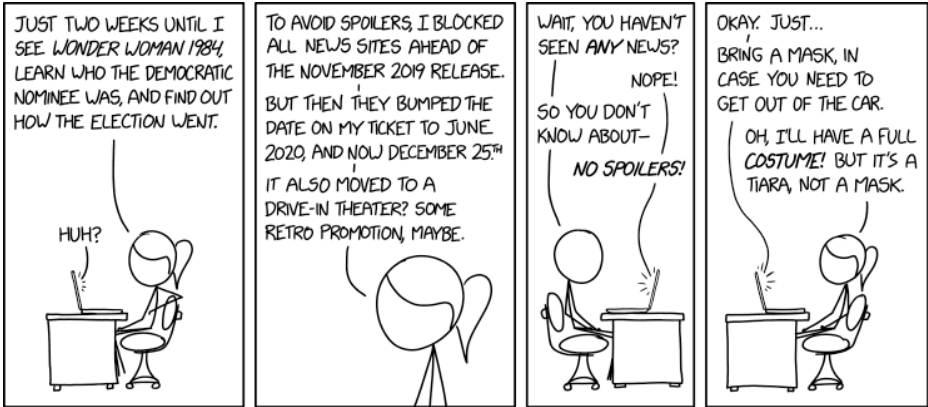
This comic seems to represent the problem that precautions that are insufficient feel excessive to many people and vice versa, thus there is such a large overlap between the 2 sections. Even a moderately sensible individual will likely consider some blanket precautions restrictive because they don't allow a nuance of behavior they think they should be able to embrace safely; meanwhile they'll find some of the actual official exceptions, that probably do not apply to them, to be taken reckless advantage of by others. Additionally, neither range mentions whether the precautions are actually effective, which also can have a level of subjectivity.

Randall points out that part of the challenge with finding the 'right setting' is that you can only know for sure that your precautions were insufficient if and when you catch COVID and either get tested or develop symptoms, by which point it is too late to change your precautions (although your case could at least inform others). However, some people do not take precautions seriously even though they believe in COVID because they view it as a mild disease, like the common cold or influenza, that won't kill them, and there have been people who contracted COVID-19 multiple times, so perhaps Randall was referring to dying from COVID-19

instead.

## #2396: Wonder Woman 1984

December 09, 2020



'Wait, why would you think a movie set in 1984 would do drive-ins as a retro promotion?' 'You know, 80s stuff. Drive-in movies. Britney Spears doing the hustle. Elvis going on Ed Sullivan and showing off his pog collection.' 'What year were you born, again?'

## Explanation

This comic is another in a series of comics related to the COVID-19 pandemic.

Ponytail, who was eager to see Wonder Woman 1984, the 2019 sequel to the acclaimed 2017 Wonder Woman film, decided to block all news media leading up to the film, to avoid spoilers. Avoiding spoilers is a common practice for people who do not wish to be "spoiled" by reading or hearing any plot points of the film, because they want to be immersed in the movie when watching it for the first time, by not being able to predict any plot twists before they occur. Many early reviewers may inadvertently give away key parts of the film, which may ruin the experience for some watchers, and story elements may be leaked by inside sources, either accidentally or deliberately.

However, there have been many delays for release of the film, in part because of the COVID-19 pandemic in the spring of 2020. The film was originally delayed from November 1, 2019 to June 5, 2020 to allow more time for production, and then, after the pandemic struck, was pushed to August 14, 2020, then October 2, 2020, before it was finally moved to December 25, 2020. The film studio announced a simultaneous release of the film in theaters and also on streaming platform HBO Max.

Absurdly, Ponytail apparently continued to block news sites after the delays, and so has not read any news in over

a year, even news unrelated to movies. Because of this, she is apparently totally unaware of the entire pandemic, as well as more predictable major news items like the 2020 United States presidential election. This is particularly absurd, because these events were influential enough that it would be difficult or impossible to avoid awareness, even with no media exposure. They have been common topics of conversation, not to mention face-masks and other public health-control measures have now become ubiquitous, and election campaign signs and bumper stickers were common sights in the lead-up to November.

How the release date being postponed (twice) did not convince Ponytail to find out why, therefore becoming aware of the pandemic with its associated lockdown and public health-control, is a question that is left unanswered. Her confusion as to why her movie is now being shown at a drive-in theater is a sign that she's unaware of COVID-19. Drive-in theaters have been seen as a safer option than indoor movie theaters during the pandemic.

Cueball tries to warn her about the ongoing pandemic, but in an effort to avoid spoilers, she silences him. This may imply that in her wildly excessive effort to avoid spoilers, she's avoided leaving her home and talking to people, which could explain her exceptional level of disconnection from current events. Cueball then tells her to wear a mask, but she is still confused. Ponytail says that she will dress up in costume as Wonder Woman, who is traditionally shown wearing a tiara but not a mask

(unlike Batman or many other comic characters, although efficiency of their masks still varies wildly in regards to COVID-19 protection).

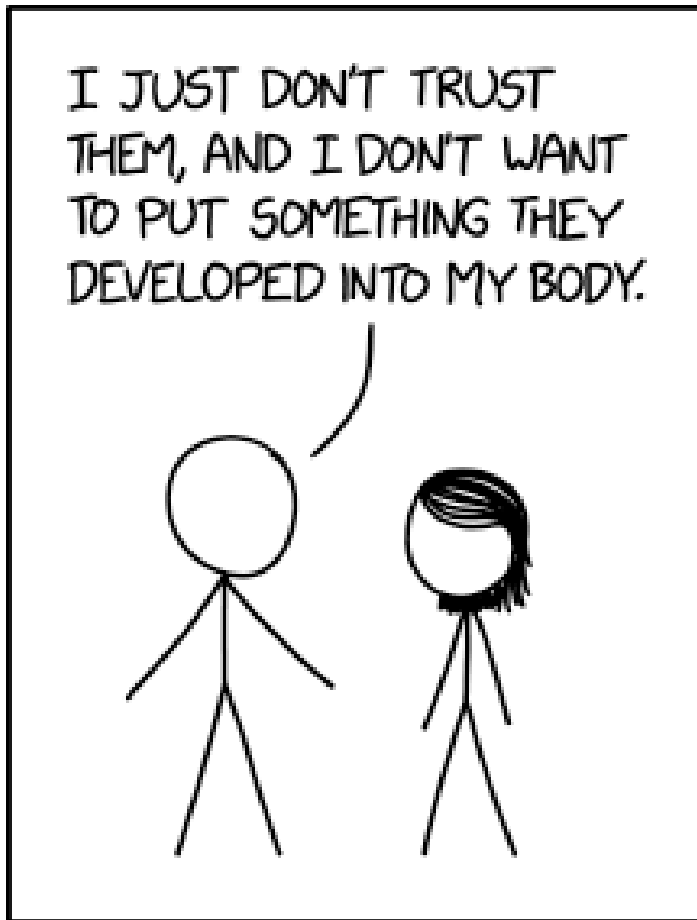
The title text expands on Ponytail's speculation that the use of the drive-in theaters is a "retro promotion," presumably because drive-ins and the '80s setting of the movie are now both considered to be retro in 2020. However, they are not associated with the same period; drive-in theaters in America had their heyday in the 1950s and '60s, and were in rapid decline by the '80s. Ponytail further demonstrates her misunderstanding of history by mentioning several other things which she wrongly believes are from the '80s. Britney Spears is a singer who was popular in the late 1990s and early 2000s. The Hustle was a disco dance popular in the mid-1970s. Pogs under that name peaked in the mid-1990s. Elvis's appearance on the Ed Sullivan Show - a pivotal moment in American pop culture - occurred on September 9, 1956. (The Ed Sullivan Show went off the air in 1971, Ed Sullivan died in 1974, and Elvis Presley died in 1977.[citation needed]) This joke concerns the phenomenon of people lumping together all time periods before their birth, which results in "retro" or "period" representations combining elements from widely different time periods. (A similar behavior is seen in 771: Period Speech.) Cueball points this out by asking Ponytail when she was born, implying that, if she'd actually lived through any of those time periods, she'd realize that they were distinct. If Ponytail could not remember any of these events in her childhood, an age of

about 20 years can be set as an approximate upper bound for this particular character's age.

This comic is similar to 2280: 2010 and 2020 and 2338: Faraday Tour, which also involve characters who are unaware of the COVID-19 pandemic.

## #2397: I Just Don't Trust Them

*December 11, 2020*



## HOW I FEEL ABOUT BATS

I believe in getting immunity the old-fashioned way: By letting a bat virus take control of my lungs and turn my face into a disgusting plague fountain while my immune system desperately Googles 'how to make spike protein



antibodies'.

## Explanation

This comic is another in a series of comics related to the COVID-19 pandemic, specifically regarding the COVID-19 vaccine.

Cueball partially echoes a statement made by anti-vaccination activists about "Big Pharma" (the powerful and profit-driven companies which develop pharmaceutical drugs such as vaccines). Anti-vaccine protesters falsely believe that vaccines contain harmful toxins (such as HIV proteins, aluminum salts, formaldehyde, mercury, and nanoparticles) that cause ill effects on the human body, that just because there has never been a licensed mRNA vaccine before that these new vaccines are not safe in the long term, and that the corporations that make them are not to be trusted because they are exploiting a captive public for profit while disregarding public health. The joke is that Cueball is revealed to be not talking about Big Pharma but, instead, bats.

According to the WHO, COVID-19 has an ecological origin in bat populations. Hence, Cueball sees the virus as something developed by bats, and the ambiguity by which he expresses his desire to not be infected adds to the joke.

The comic could simply be seen to serve as a compelling argument against the anti-vaccine movement, which is often criticized for spreading misinformation and

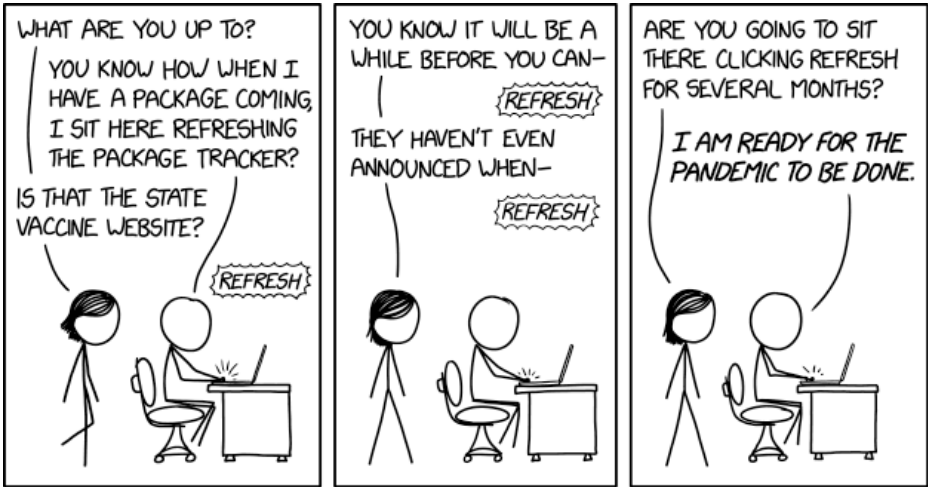
increasing rates of disease, especially since the start of the COVID-19 pandemic. This comic comes shortly after the news of the development of several COVID-19 vaccines with high rates of success; there are concerns that herd immunity may be delayed if people refuse to take the vaccine.

The title text refers to getting immunity the old-fashioned way, i.e. catching the disease and waiting for your immune system to build up a response. This is usually considered healthy when immunity to minor diseases is common, and can avoid the sudden forced evolution of new diseases among extensively hypercareful communities, but developing natural immunity is certainly incredibly dangerous during a pandemic of a serious illness. One joke here is that many anti-vaxxers claim that it is more natural to not take a vaccine. Because many people conflate "natural" with "healthy", the assumption underlying the claim "it is more natural to not take a vaccine" is that it is therefore more healthy. Such arguments are an example of the logical fallacy known as Appeal to nature. Thus, the title text is apparently written from a pro-vaxxer's take on the stance of an anti-vaxxer.

The title text also playfully suggests that the immune system would attempt to use an Internet search engine to learn how to manufacture spike protein antibodies. While this may be an effective technique for a human being to acquire knowledge, it would not likely be as efficient for a nonsentient biological system.[citation needed]

## #2398: Vaccine Tracker

December 14, 2020



\*refresh\* Aww, still in Kalamazoo. \*refresh\* Aww, still in Kalamazoo.

## Explanation

This comic is another in a series of comics related to the COVID-19 pandemic, specifically regarding the COVID-19 vaccine.

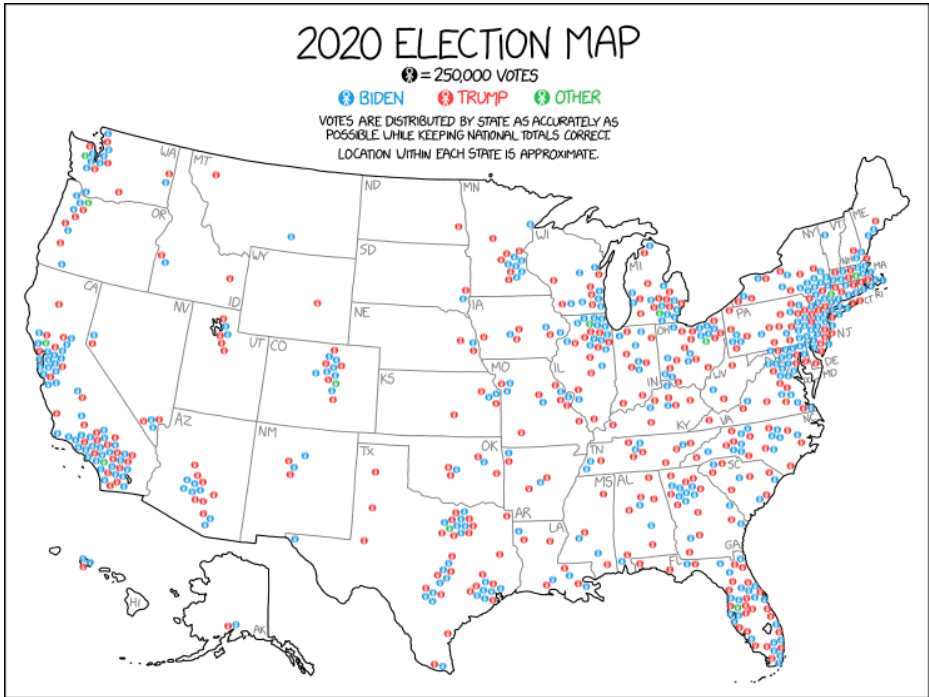
Similar to 281: Online Package Tracking, Cueball is trying to "track" the status of the Pfizer COVID-19 vaccine, which was approved in the USA the week prior to the publishing of this comic, and began to be administered the day of publication. Cueball is impatient for the vaccine to be released to the public, wanting the pandemic to end as soon as possible. Because of that, he is treating the state vaccine website like a package tracker, even though it will probably be several months before he is vaccinated.

Of course, the state vaccine website does not act like a package tracker, and updates will be few and far between. The comedy in this comes from Cueball expecting it to update regularly, even though the vaccine is not going to come anytime soon for most people, especially for those in Cueball's presumed priority level. Checking once a day for general 'movement' probably would more than suffice to get a head's up on when a possible invitation or opportunity to book would present itself.

The title text refers to Pfizer's vaccine plant in the city of Kalamazoo, Michigan, and is also a reference to 281: Online Package Tracking.

## #2399: 2020 Election Map

December 16, 2020



There are more Trump voters in California than Texas, more Biden voters in Texas than New York, more Trump voters in New York than Ohio, more Biden voters in Ohio than Massachusetts, more Trump voters in Massachusetts than Mississippi, and more Biden voters in Mississippi than Vermont.

## Explanation

This is a sequel to an earlier comic, 1939: 2016 Election Map. The United States elects its president not directly by popular vote but by an Electoral College composed of a number of electors, partially proportional to population, from each state. Presently, a "winner-take-all" system is used in most states: the winner of the popular vote in each state receives all of the electoral votes for that state. Though, strictly speaking, the electors are not required to cast their ballots according to this system, many states impose penalties on them if they don't. Technically, the popular vote in each state is to elect a slate of electors who in turn elect the President.

During the election season, news outlets and other political trackers tend to color-code each state with the party which won the state (or which is projected or speculated to win). Since the 2000 election it's become common practice to code Republican victories as red and Democratic victories as blue. Other parties have less consistent colors, but are commonly green. These colors have become embedded in popular vernacular, as states that are heavily Republican are known as "red states" and those that are heavily Democratic are known as "blue states".

These graphics can be misleading as to the realities on the ground, though. Because each state is colored solidly red or blue, it gives the impression that each state belongs

entirely to one party or the other, when the color could represent a very slender minority, or an overwhelming advantage. In addition, such a graphical view means that larger states translate to more area of a given color, giving the impression of party strength, even though that may not represent many voters. In the US, large cities trend largely Democratic, while rural areas trend largely Republican. This means that many Democratic voters are concentrated in relatively small urban areas, so a large "red" state may represent fewer voters than a small "blue" state.

Randall's solution to this is to represent the Republican and Democratic voters in each state with Cueball icons, each icon representing 250,000 voters. He has made some attempt to distribute the Cueball icons within a state in a manner similar to how the actual votes were distributed. This has the advantage of giving a decent impression of how popular each candidate was, how their popularity varied across the country, and how the votes were distributed by both state and region. It also gives at least a basic indication of population patterns in the US, with large regions that are sparsely inhabited, and populations clustered in urban centers.

The title text compares different voter pools in terms of absolute size. These facts are frequently counter-intuitive. California is generally thought of as a "blue state", and Texas as a "red state" (Although that may be changing), so it's surprising to realize that, in 2020, Donald Trump received more votes in California than he did in Texas. The reason for this is not complex,



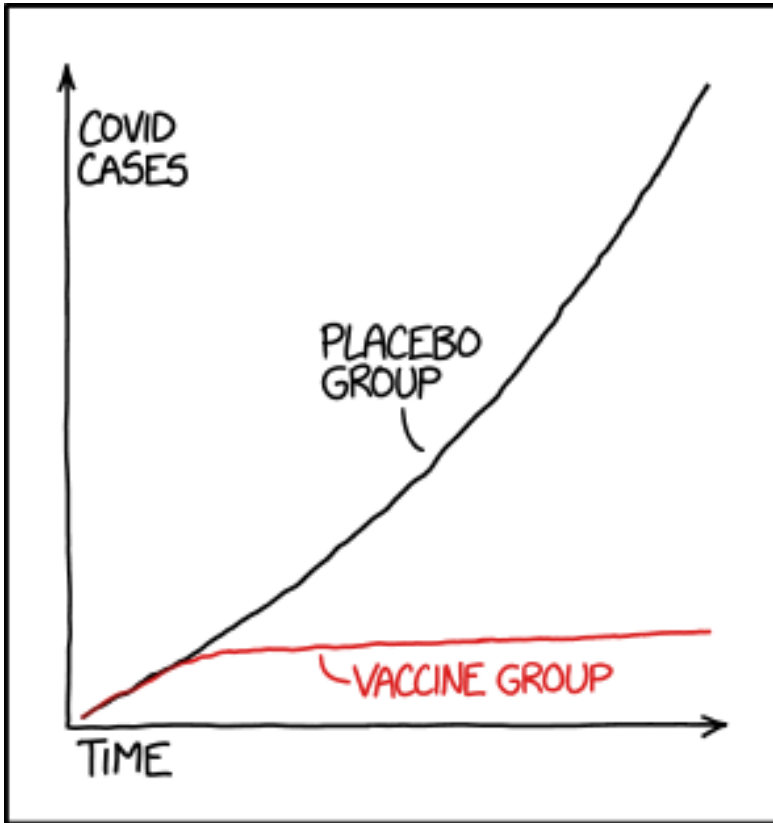
California has a huge population, nearly 40 million people, of whom 17.5 million voted in 2020. Even though Joe Biden won the state easily, Trump received 6 million of those votes. Texas, by contrast, has 27.7 million residents and 11.3 million voters in the 2020 election. Trump received 5.9 million of those votes, which was enough to win the state. Because of the huge variation in population among US states, and the political divisions within each state, there are multiple "blue" states which have more Republican voters than at least some "red" states, and vice versa. This underscores the importance of not viewing any state as politically uniform. Even if a state trends heavily toward one party, there is always a substantial population of the other party, and in large states, which means enough people that they'd be a formidable political force anywhere else.

### Source

The following table lists the number of 250,000-vote markers in the map by candidate and state, and compares this with the actual number of votes. Source

## #2400: Statistics

December 18, 2020



STATISTICS TIP: ALWAYS TRY TO GET DATA THAT'S GOOD ENOUGH THAT YOU DON'T NEED TO DO STATISTICS ON IT

We reject the null hypothesis based on the 'hot damn, check out this chart' test.

## Explanation

This comic is another in a series of comics related to the COVID-19 pandemic, specifically regarding the COVID-19 vaccine. It is also another one of Randall's Tips, this time a statistics tip. The next tip comic after this 2435: Geothmetic Meandian had a stats tip.

### Graph[edit]

The main focus of the comic is a graph showing cases of COVID-19 versus time for two groups: one group was vaccinated and the other group was not. Graphs are ways to visualize data, and for real data indicate specific values. This graph seems to be based on the Pfizer vaccine's results. The higher line ("placebo group") rises in a steep curve. The lower line ("vaccine group") follows the first for a bit but then levels out to a much slower rate of climb. Officially, a scientific assessment of the effectiveness of anything requires rigorous statistical analysis. This is particularly true in medical studies, where impacts of biology can be highly complex and subject to many factors, meaning that careful review of the data is necessary to confirm that an intervention was effective. The joke of this comic is that the intervention presented here is so obviously effective that it's obvious even to a layman with little understanding of the math. A few days after the vaccine was administered, cases in the vaccinated group essentially flatline, while cases in the placebo group continue to rise at a significant rate. The data is so "good", meaning that numbers for the treatment and control groups diverge so dramatically, that actual analysis becomes almost a formality: a glance at the chart would convince most people that the treatment is effective.

This comic was released one week after the FDA granted an emergency use authorization for the Pfizer COVID-19 vaccine, and 8 days after results of its Phase 3 clinical trial were published in the New England Journal of Medicine. The document includes the following chart. The charts draw the integral of the incidence data rather than the data itself ("cumulative" rather than "rate"): this results in changes in disease rate towards the left side of the chart, being added into the data on the right side, amplifying their difference. This technique for emphasizing the data is valid: the spread between the lines only continues to increase if the effect continues happening, such that the total spread at the right is proportional to the total effect the vaccine had. The charts do not show any information on other possible variables. Randall has described previously in his webcomics how very clear charts can be made to hide misleading data. The linked graph does not leave the numbers out, and the numbers indicate the vaccine is 91% effective at preventing the disease (and a 95% chance of being between 85 and 95% efficient).

The advice here could be seen as the inverse of the "science tip" in 2311: Confidence Interval, in which the data was so bad that its error bars fell outside of the graph and were not shown. Also there's some association with 1725: Linear Regression where the data is not so good that you don't need to perform linear analysis.

## **Null hypothesis[edit]**

The null hypothesis, mentioned in the title text, is the hypothesis in a statistical analysis that indicates that the effect investigated by the analysis does not occur, i.e. 'null' as in zero effect. For example, the null hypothesis for this study might be "The vaccine has no effect on whether subjects catch COVID." The null

hypothesis was previously the subject of 892: Null Hypothesis. The null hypothesis is rejected when the probability of something like the observed data would be very low were the null hypothesis true.

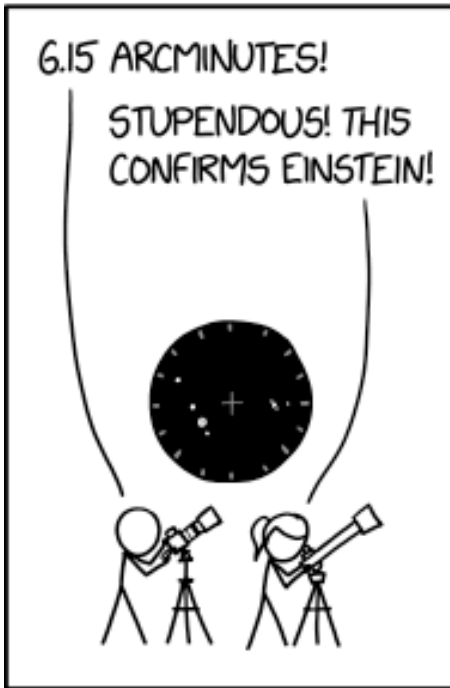
For a simplified example, imagine there are 10000 people in the vaccinated group, and each has a 5% chance of catching COVID under the null hypothesis; we expect 500 people to catch COVID. If only 490 catch COVID, the null hypothesis remains plausible, but if just 10 do, the odds are (in Python; see binomial distribution)  $\sum(\text{math.comb}(10000, i) * 0.05^{**i} * 0.95^{**}(10000-i) \text{ for } i \text{ in range}(0,10)) = 1.5 \times 10^{-204}$ . In other words, it is wildly improbable that an ineffective vaccine would have produced such excellent results. We therefore conclude that the vaccine is not ineffective, and have rejected the null hypothesis.

Most people however, on seeing the raw results, would have concluded that the vaccine worked and statistics were just a formality. As the title text says, they would have "reject[ed] the null hypothesis based on the 'hot damn, check out this chart' test."

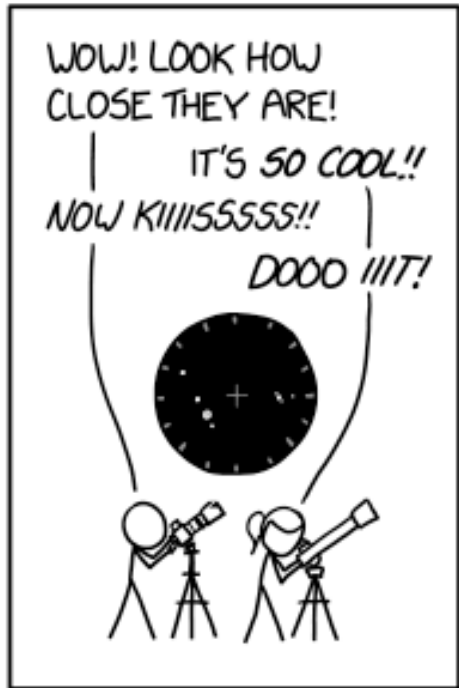
## #2401: Conjunction

December 21, 2020

WHAT PEOPLE IMAGINE  
ASTRONOMERS OBSERVING  
A CONJUNCTION ARE LIKE



WHAT THEY'RE  
ACTUALLY LIKE



The IAU is sad to announce that at 00:39 UTC on December 22nd, Jupiter and Saturn did unfortunately come into contact, and appear to have blooped together.

## Explanation

Cueball and Ponytail are observing the 2020 Jupiter-Saturn conjunction. This comic is similar to other comparisons between expectation and reality, such as 2176: How Hacking Works, 683: Science Montage, 2341: Scientist Tech Help, and 538: Security. The expectation is that the scientists will remain professional and serious throughout the event, testing Einstein's theory of General Relativity and using technical terms such as arcminute, a unit of measurement often used in astronomy. In reality, however, they are actually treating the event quite whimsically and are having fun with it, even jokingly commenting about the event and shipping the two planets. Other astronomical phenomena, such as solar eclipses, actually have been used to test Einstein's theories, but in this case the interest is purely aesthetic.

The title text references the misconception that the planets physically get very close at conjunction, rather than merely appearing to do so. The wording suggests a quick and uneventful merger, possibly alluding to the way drops of water merge when the surface tension between them is broken.

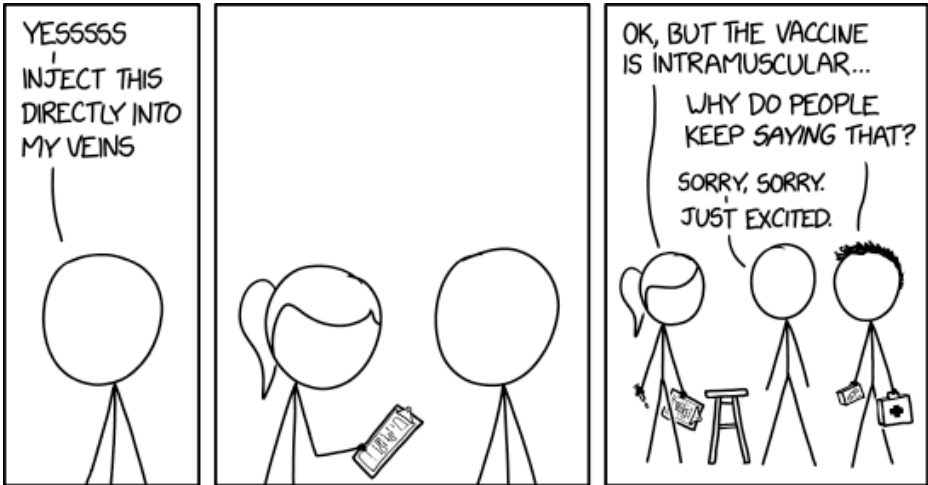
If Jupiter and Saturn really did come into contact and "blooped together", most of the mass would stay collected as an extremely hot[citation needed] and turbulent blob that would eventually settle down as a new planet (which Randall suggests might be called "Jaturn"), but more than a bit would be spewed

outwards. The possible outcomes vary enormously, depending on factors such as how direct the impact was, and its alignment relative to the planets' spins. However, while such a collision would be preceded by a conjunction, a conjunction does not necessarily indicate an imminent collision, as Jupiter and Saturn, although on the same sightline from Earth, are still separated by 734 million km (456 million mi) at the time of the conjunction - almost five times the distance from Earth to the Sun.



## #2402: Into My Veins

December 23, 2020



"Okay, for the last time, the shot is free, so we can't--"  
"Shut up and take my money!"

## Explanation

This comic is another in a series of comics related to the COVID-19 pandemic. It also references a common meme.

Two of the next four comics also contain references to the vaccine, 2404: First Thing and 2406: Viral Vector Immunity, and the first of these, like this one, additionally references a common Internet trend.

The COVID-19 pandemic has been one of the most consequential and broadly unpleasant events in living memory.[citation needed] As of the publication of this strip, it is estimated to have caused over 1.5 million deaths worldwide, with over 300,000 deaths in the United States, and many more serious cases, often with lasting impacts. Even for those who have been spared infection, measures to slow the spread of the virus have been highly impactful, and have been ongoing for nearly a year.

As a consequence of all of this, many people (including, presumably, Randall) are excited for the vaccine, which will hopefully end the pandemic. This comic shows Cueball clearly thrilled to receive the vaccine. "Inject this directly into my veins" is a meme based on a line (from *The Simpsons*): in the episode "A Star Is Burns", an alcoholic character wins a lifetime supply of beer, and replies "just hook it to my veins". The meme is typically applied to things that are not injected at all (such as a

form of media or entertainment) to express exaggerated enthusiasm. When Cueball applies the meme to the COVID-19 vaccine, it causes some confusion, because the vaccine is delivered by injection, but not directly into a vein. The medical staff delivering the vaccine have apparently heard this or similar lines frequently, and appear to take it literally, explaining that it's intended to be administered intramuscularly (usually in the upper arm). In fact, at least one study has shown that inadvertent intravenous injection of COVID-19 mRNA vaccines may induce myopericarditis, i.e., inflammation of the pericardium (tissue surrounding the heart), although this claim has been disputed.

The title text references another such meme, "Shut up and take my money," which derives from the 2010 "Attack of the Killer App" episode of Futurama. This meme, like the first, expresses extreme and immediate desire for something, with the implication that the speaker is not only willing but eager to pay whatever it costs, and is too excited to wait for a sales pitch or for any warnings or disclaimers. The COVID-19 vaccine is being provided free of charge to Cueball, so taking his money is entirely unnecessary (and possibly illegal). Once again, this is a source of potential confusion because, under the American healthcare system, many people likely will have to pay at least part of the cost of vaccination. The workers administering it could easily confuse the meme for a genuine request.

This was the last comic before this year's Christmas comic. It was about the COVID-19 vaccine. The last

comic before the 2021 Christmas comic, 2558: Rapid Test Results, was about COVID-19 tests.

## #2403: Wrapping Paper

December 25, 2020

COOL! I GOT THE ENTIRE UNIVERSE  
AND EVERY OBJECT WITHIN IT  
EXCEPT FOR A PAIR OF HEADPHONES!



PRESENTS GET A LOT MORE IMPRESSIVE IF  
YOU TURN THE WRAPPING PAPER INSIDE OUT

Wow, rude of you to regift literally every gift that you  
or anyone else has ever received.

## Explanation

This comic was the Christmas comic of 2020 and was published on Christmas Day, a day where people who celebrate Christmas traditionally open presents.

In this comic, Megan is unwrapping a present while Cueball looks on (perhaps it's the present he gave her). The premise is that the definition of a present is not what's inside the box, but what's inside the region of space that the blank side of the wrapping paper faces. So if you wrap the box with the printed side towards the box, everything in the universe outside the box is the gift. Apparently, the box contains a pair of headphones, which would be a nice present, but not nearly as impressive as almost everything in the universe.[citation needed] And since the rest of the universe contains millions of headphones, many of which are probably nicer than the ones in this box, she still gets headphones as well.

The title text extends this to regifting, which is the practice of using a received present (usually unwanted and hopefully unused) as a present for someone else. This practice is often considered to be impolite because it's assumed to simultaneously show a lack of appreciation of a gift you've received (because you want to get rid of it), and an unwillingness to spend much time, effort, or money on a gift for someone else. But if you wrap an ordinary present inside out, all the gifts you've ever received in the past are part of the entire

universe except for that present, so you're actually doing an enormous amount of regifting including stuff belonging to other people, which is as rude as regifting can get.

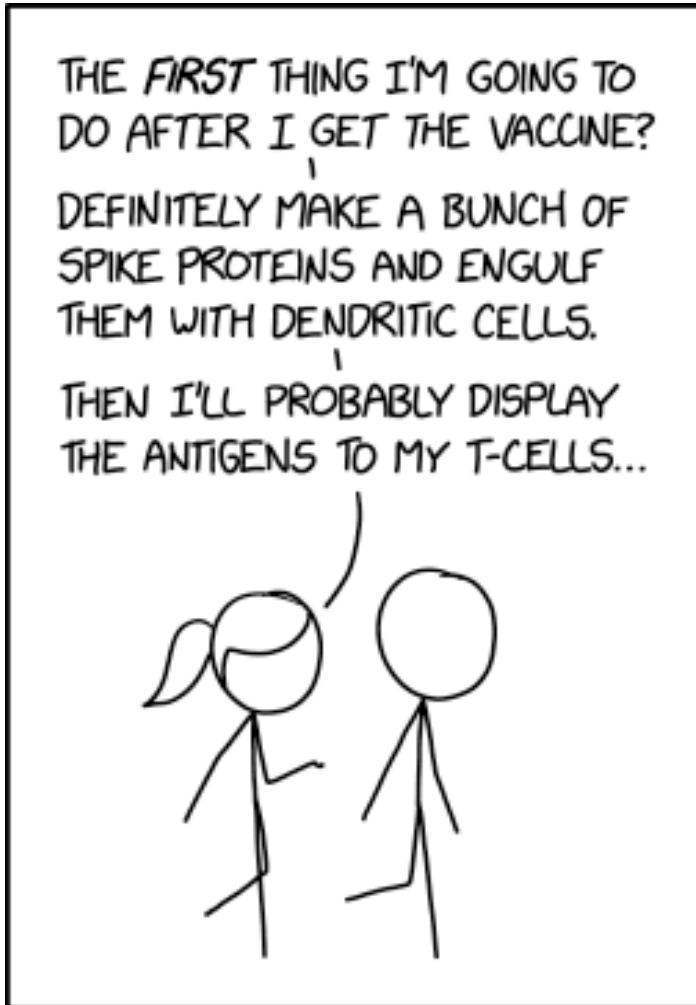
Douglas Adams's novel *So Long, and Thanks for All the Fish*, the fourth in the *The Hitchhiker's Guide to the Galaxy* series, contains a similar joke. A man living in an inside-out room in a desert treats the rest of Earth as an insane asylum, with himself living outside of it as the only sane man.

This may also refer to a math joke about how to create the smallest fence around a group of animals. Rather than finding the obvious fence, a mathematician would build a small, circular fence around themselves and declare the region on the other side of the fence "inside", thus enclosing all the animals!

The mention of headphones might be a reference to the AirPods Max, which were released by Apple on December 9, just 16 days before this comic, and stirred much debate for their USD\$549 price tag.

## #2404: First Thing

*December 28, 2020*



Then I'm going to go on a weeks-long somatic hypermutation bender, producing ever-more targeted antibodies, while I continue to remain distanced and follow guidance from public health authorities.



## Explanation

This comic is another in a series of comics related to the COVID-19 pandemic, specifically regarding the COVID-19 vaccine.

This comic, somewhat like 2402: Into My Veins, references both the COVID-19 vaccine and a common Internet trend. Two comics later in 2406: Viral Vector Immunity, the vaccine is again referenced.

The COVID-19 pandemic has been one of the most consequential and broadly unpleasant events in living memory[citation needed]. As of the publication of this strip, it is estimated to have caused over 1.5 million deaths worldwide and over 300,000 deaths in the United States. Many more cases that have not resulted in fatality often need serious medical support and/or have lasting implications. Even for those who have been spared infection, measures to slow the spread of the virus have been highly impactful and have been ongoing for nearly a year.

In consequence of all of this, many people are excited for the vaccine (which later resulted in the pandemic successfully ending). Many people online have been sharing plans for what they'll do after getting the vaccine, like "see my friends" or "travel the world." In this comic, Ponytail takes the phrase literally, listing not what she will voluntarily choose to do but what low-level involuntary systems in her body will do immediately

after getting the vaccine:

- First she will make some spike proteins. This implies that she took an mRNA vaccine (e.g. from BioNTech or Moderna) or a viral-vector vaccine like the ones from AstraZeneca, Janssen Vaccines, or CanSino. mRNA vaccines contain RNA encoding for the viral proteins, which is then used by Ponytail's cell to make the spike protein. Viral-vector vaccines contain DNA, which the viral "shell" introduces into human cells, which then manufacture spike proteins. (In contrast, subunit-containing vaccines like the ones from Novavax contain actual duplicates of viral proteins to sensitize the immune systems, and inactivated/weakened virus-based vaccines contain the actual virus in question, but modified to not cause disease, e. g. the vaccines from Sinovac and Sinopharm.)
- The spike protein made by Ponytail will then be recognized by her immune system as foreign (as would the proteins of the real coronavirus) and subsequently engulfed by the dendritic cells in a process called phagocytosis.
- The dendritic cells then chop the spike proteins into small pieces (called antigens) and present them on their surface using MHCII proteins.
- This will then allow T-cells to recognize these pieces and become activated if they have a matching T-cell receptor.

The next step is mentioned in the title text:

- The T-cells will activate B-cells, who will then try to make antibodies to bind the spike protein. Since the B-cells don't know what a good antibody looks like, they just randomly generate antibodies through a process of somatic hypermutation. Then they check if the antibody binds the antigen presented by the dendritic cells. If it doesn't the antibody is discarded, if it does, it is kept and improved on by another round of somatic hypermutation, to create an antibody which binds even better.
- Finally Ponytail mentions the things she herself (as opposed to her immune system) has to do: continue to use social distancing, hand washing, wearing a mask, etc.

The last point, which are the only things that Ponytail will choose to do is important, for a number of reasons. The vaccines currently available offer a great deal of protection to an individual patient, but that protection takes several days to even begin in a significant way. Full immunity will likely require several weeks and an additional dose. In addition, while highly effective, the current crop of vaccines are not 100% effective. And even those who develop immunity can become contaminated with the virus on their person and then transmit it to others.

For all of these reasons, there is a very real fear of people who receive vaccinations immediately abandoning all other precautions and continuing to spread the virus. Genuinely ending the pandemic will require precautions

to remain in place until enough of the population is vaccinated that a combination of high levels of population immunity and other distancing precautions lower the infection rate to a controllable level. Abandoning safety precautions before this occurs could extend the pandemic and cost lives. Accordingly, Ponytail's intent is to be responsible and maintain all appropriate precautions until such time as it's safe to change them.

## #2405: Flash Gatsby

December 30, 2020



THERE'S ONLY A VERY SHORT WINDOW OF TIME IN WHICH I CAN POST MY UNAUTHORIZED FLASH® ADAPTATION OF *THE GREAT GATSBY*.

Protip: At midnight your excuse for not having read *The Great Gatsby* can switch from "I'm worried about violating copyright" to "I think my copy requires Flash."

## Explanation

This comic unfolds over the last few seconds of 2020 and the first few seconds of 2021. Cueball is attempting to do something requiring the overlap of two events that only technically abutted each other: The Great Gatsby entering public domain and Adobe Flash still being supported.

The Great Gatsby is a classic novel written by F. Scott Fitzgerald in 1925. Copyright law in the United States of America, where The Great Gatsby was first published, was retroactively extended several times in the 1990s and early 2000s, causing the copyright on The Great Gatsby to extend until the end of 2020. In 2021, it finally entered the public domain so that it became legal to make a copy without violating copyright law.

Adobe Flash, formerly known as Shockwave Flash, is a web plugin that was commonly used by many websites in the late 1990s and 2000s. It allowed website creators to add animations, sound, and complex logic to build games, videos, and other interactive experiences. Presumably, the Flash version of the novel is some kind of interactive reader, animated cartoon, or perhaps even a game.

Over the years, Adobe Flash was repeatedly exploited by hackers, incurring heavy costs on Adobe as they tried to update Flash against these attacks after rushing features out before stabilizing them. Newer technologies are now

able to provide comparable features with more compatibility, more community involvement, and less risk, so support for Flash is being phased out by most web browsers. Adobe officially ended support for Flash after December 31, 2020.

In line with Adobe's decision, Chrome is blocking Flash in January. This will make entire internet culture histories spanning many years of making and engaging Flash experiences unusable for most people. Therefore, Cueball's Flash version of *The Great Gatsby* will become legal at the very moment that everyone should stop using it.

In this comic, Cueball suggests that the withdrawal of Flash support occurs after the copyright expiration rather than simultaneously with it. This is most likely because the applicable copyright law in the United States states that the creative work becomes public domain at the end of the year 2020 and Flash gets disabled at the beginning of the year 2021. So it is conceivable (but not practical) that there is one second when the novel is public domain and Flash is still enabled.

By late 2020, Flash Player was already blocked by most browsers, but could still be whitelisted on individual sites. Using old versions of browsers, or workarounds to run blocked extensions, Cueball's *Great Gatsby* may still be readable after the official Flash End of Life date of January 1, 2021. Even with these workarounds, Flash Player itself will block Flash content from playing on January 12, 2021, making that the final death date for

official modern versions of Flash.

After January 12, Flash content may still be accessible through older builds of Flash Player, and through various archival and emulation projects, such as the Internet Archive, Ruffle, Flashpoint Archive, and SuperNova.

The title wording has a number of possible meanings to it. It's the 'Gatsby' book via the medium of the electronic Flash format. Because of the briefest of availability (at best, a single moment), it appears and disappears again 'in a flash'. Being 'flash' is a very apt description of the millionaire Gatsby character himself ('Flash the cash' is being ostentatious). And, if the endeavor is not actually as legitimate as hoped, the word has also referred to felonious behaviors and forged copies.

The title text references using excuses for not having read a book considered a classic. Before the end of 2020, a possible excuse for not trying to read it was it may not have been available in the format a person wanted it (such as via a flash program in this case) and it might have been illegal (copyright violation) to get it in that format. After 2020, the new excuse to not read it could be a technical one (flash doesn't work/nothing capable of running flash). Both excuses are quite flimsy; it's apparent the person really just doesn't care to read *The Great Gatsby*.



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